AD616396

Best Available Copy

C. W. THORNTHWAITE ASSOCIATES

LABORATORY OF CLIMATOLOGY

RECENT DEVELOPMENTS IN METEOROLOGICAL SENSORS AND MEASURING TECHNIQUES TO 150,000 FEET

PART II. BIBLIOGRAPHY

Final Report
Contract No. DA-28-043 AMC-00001(E)
DA Task No. 1VO-14501-B-53A-02
U.S. Army Electronics Laboratories
Ft. Monmouth, New Jersey

BEST AVAILABLE COPY

20040831039

Centerton, New Jersey
April 30, 1965

[redacted]

C. W. THORNTHWAITE ASSOCIATES

LABORATORY OF CLIMATOLOGY

RECENT DEVELOPMENTS IN METEOROLOGICAL SENSORS AND MEASURING TECHNIQUES TO 150,000 FEET

PART II. BIBLIOGRAPHY

Edited by
John R. Mather

with contributions by

Richard T. Field John R. Mather
F. Kenneth Hare Fred L. Mowry
William J. Superior

Final Report
Contract No. DA-28-043 AMC-00001(E)
DA Task No. 1VO-14501-B-53A-02
U.S. Army Electronics Laboratories
Ft. Monmouth, New Jersey

Centerton, New Jersey
April 30, 1965

FINAL REPORT UNDER CONTRACT NO.
DA-28-043 AMC-00001(E)

The research reported in this document has been sponsored by the U. S. Army Electronics Laboratories, Ft. Monmouth, New Jersey, under Contract No. DA-28-043 AMC-00001(E). Reproduction of material in this report either in whole or in part is permitted for any purpose of the United States Government.

TABLE OF CONTENTS

PART I. ANALYSIS

PART II. BIBLIOGRAPHY

BIBLIOGRAPHY

Entries at the beginning of each section give cross reference to articles of interest contained elsewhere in the bibliography. Each article has been numbered. The number in the author index and at the end of the cross reference section refers to the entry number in the bibliography. Entries and annotations have been obtained from a number of different sources. These are listed at the end of each entry by means of a letter in brackets. Abbreviations are as follows:

MA	Meteorological and Geoastrophysical Abstracts
PA	Physics Abstract
CA	Chemistry Abstracts
R	Stanford Research Institute (Robinson's 1962 Report)
STAR	Scientific and Technical Aerospace Report (NASA)
EI	Engineering Index
AID	Aerospace Information Division, Library of Congress

AUTHOR INDEX

GENERAL

1. Air Force, Geophysics Research Directorate, 1960: Handbook of Geophysics--Revised Edition. MacMillan Co., New York. /R/

2. Air Force Missile Test Center, 1963: Meteorological handbook. Air Force Missile Test Center, AFMTCP 105-1, 32 p. AD 432 132.

3. Alekseyev, P.P. et al., 1962: Izuchenie vysokikh sloev atmosfery pri pomoshchi meteorologicheskikh raket. /Study of high atmospheric layers with the aid of meteorological rockets./ Vsesoiuznoe Nauchnoe Meteorologicheskoe Soveshchanie, 1st, Leningrad, June 1961, Trudy, 1, 91-103.

The use of rockets to obtain atmospheric soundings at altitudes of 50-80 km in the U.S.S.R. is discussed and some meteorological data obtained are presented and analyzed. The operational characteristics of this type of membrane manometers (range of 760 to 10 mm Hg) and the thermal manometer of the Pirani type (5 to $5x10^{-3}$ mm Hg), of the special resistance thermometers, and of the telemetering systems and the measurement of wind up to 50 km by radar observation of the drift of the cone of a rocket are described. The equation for calculating pressure, temperature, and wind speed and direction are presented. With the aid of data presented in a table, the authors discuss some of the results of measurements (obtained by the Central Aerological Observatory) of seasonal variation of temperature, temperature stratification of the stratosphere, temperature inversion above the stratosphere during the polar night, the temperature field over the Northern Hemisphere, and the circulation in the stratosphere and mesosphere. /MA/

4. Atlas, David, 1962: Indirect probing techniques. Bull. Am. Met. Soc., 43 (9), 457-466.

"Indirect probing" of the atmosphere is defined as any method capable of measuring an atmospheric parameter or detecting the presence of atmospheric structures from a distance. It is based upon the measurement of some sort of radiation. The author discusses the methods of infrared and microwave radiometry, optical lasers, the electromagnetic acoustic probe (EMAC), clear air radar echoes, lightning echoes, Doppler radar and rainfall mapping. A diagram of the

EMAC and graphs and radar pictures giving the results of measurements with the various systems are presented and the readings obtained are interpreted. /MA/

5. Batten, E. S., 1961: The mesosphere. Rand Corp., paper prepared for publication in the 1962 Yearbook of the McGraw-Hill Encyclopedia of Science and Technology.

During the 1960-61 period, scientific activity increased in the mesosphere prompted by an accelerated rocket program. Small meteorological rockets were developed and used more or less synoptically to probe the atmosphere to heights of 70 km. The data collected from these rockets at locations in the United States, Canada, and the Pacific Ocean, combined with data collected during the IGY, have confirmed old concepts of the circulation and temperature structure of the mesosphere and provided the investigators with new puzzles to be solved.

6. Beelitz, P., 1954: Radiosonden /Radiosondes/. VEB Verlag Technik, Berlin. /R/

7. Benton, M., 1959: The use of high-altitude rockets for scientific investigations, an annotated bibliography. Naval Research Laboratory, Bibliography No. 16. AD 230 594. /R/

8. Blagontavov, A. A., 1957: Study of the upper strata of the atmosphere by means of high altitude rockets. Vestnik Akad Nauk SSSR, 6, 25-32, (1957), translated by E. R. Hope, Directorate of Scientific Information Service DRB Canada, T257 R. AD 204 605. /R/

9. Borg Warner Controls, 1961: Analysis of national aviation meteorological requirements through 1975. 5 Volumes plus appendix. /R/

10. Brasefield, C. J., 1950: Winds and temperatures in the lower stratosphere. J. Met., 7 (1), 66-69. /R/

11. Brewer, A. W., and F. J. Scrase, 1951: Meteorological measurements. Quart. J. Roy. Met. Soc., 77, (331), 3-32. /R/

12. Campen, C. F., A. E. Cole, T. P. Condon, W. S. Ripley, N. Sissenwine, I. Solomon, ed., 1960: Handbook of Geophysics. Revised Edition, MacMillan Co., New York. /R/

13. Conover, W. C., and C. J. Wentzien, 1955: Winds and temperatures to forty kilometers. J. Met., 12 (2), 160-164. /R/

14. Dobson, G. M. B., 1963: Exploring the Atmosphere. Clarendon Press, Oxford, 188 p.

15. Faust, Heinrich, 1961: Die Bedeutung eines europäischen Forschungsraketen-Netzes /Significance of a European research rocket network/. Weltraumfahrt, 12 (3), 84-89.

The author describes the Meteorological Rocket Network, operating in North America, proposed by Hans aufm Kampe in 1958, and mentions the places for establishing a European meteorological rocket network which would include Scandinavia, the German Federal Republic, Sardinia and the Sahara. The results of various studies on the distribution of wind velocity and temperature with elevation, are discussed. These included the demonstration of a wind maxima at an altitude of 10 km, above 20 km, the establishment of "zero" layers at these altitudes, the temperature distribution at these high altitudes, the seasonal variation of the temperature and the wind components, the possible role of variations in solar ultraviolet radiation as the energy source of these variations, etc. Some of the more important studies made with high altitude rockets are summarized and graphs of some of the results are presented. /MA/

16. Fleagle, R. G., and J. A. Businger, 1963: An Introduction to Atmospheric Physics. Academic Press, New York and London, 346 p.

This book is intended as a source of information for graduate students in the atmospheric sciences, though much work is included on other aspects of geophysics. Chapter I deals with gravitational effects in the atmosphere starting from the fundamentals of Newtonian mechanics and includes sections on satellite orbits, the hydrostatic equation and atmospheric tides. Chapter II is concerned with the properties of the atmospheric gases. Elementary kinetic theory is discussed together with principles of thermodynamics. The atmosphere is dealt with from a kinetic and thermodynamic viewpoint, the equilibrium state of the atmosphere, the moist atmosphere and the distribution of temperature and water vapour being considered. In Chapter III the properties and behaviour of cloud particles is discussed in two sections, one dealing with growth and the other with the generation of electrical charge, including a discussion of the lightning discharge and the static geo-electric field. Solar and terrestrial radiation are dealt with in Chapter IV in sections concerned with (a) radiative transfer, (b) radiation outside the atmosphere, (c) effects of absorption and emission, and (d) photo-chemical processes. The solar constant, radiation measurements, measurements of the flux emissivity and divergence, the dissociation of oxygen and the airglow are among the topics discussed. Chapter V deals with transfer processes and applications of these to the atmosphere. Turbulent transfer, the vertical flux of heat and water vapour, aerosols and fog formation are dealt with. Geomagnetic phenomena are described in Chapter VI. Sections on the dynamo theory, ions and the ionospheric currents, particle motions in the magnetosphere and the aurora are included. As in the other chapters, concepts are given a mathematical basis in this chapter including the elements of Maxwell's equations and a study of the effects of electromagnetic fields on plasma. Chapter VII is titled "Atmospheric signal phenomena" and deals with sound and natural radiowaves, atmospheric refraction and scattering and nuclear explosion effects. Experimental methods of observation are discussed and a mathematical treatment of the basic concepts of wave motion, diffraction, etc. is given. Appendices deal with particular mathematical and physical topics. Each chapter includes a list of references and symbols and a set of problems, though no solutions are given for these. References refer to the latest work and the discussion after includes descriptions of work hitherto published only in scientific journals. /PA/

17. Frith, R., 1962: Meteorological satellites: future research projects. WMO Bull., 11, 202-205.

Information on the region lying above the troposphere but below the minimum orbiting height of a satellite is considered. Experiments will measure the radiation reaching the vehicle. The equipment to measure the vertical distribution of ozone will be part of the pay load of the second U.K./U.S.A. satellite. Radiation will be observed in two bands, both near the ultraviolet. When a satellite is in full sunlight the intensity in these bands will remain constant; but when the satellite is just passing into or out of the shadow of the earth, radiation from the sun must pass through the earth's atmosphere before reaching the satellite. The intensity of the solar radiation will in consequence be reduced. In the 3700-4000 Å band the reduction will be due to scattering by air, but in the 2500-3500 Å band it will also be affected by the absorption by ozone. Observations of water vapor, dust particles and noctilucent clouds will be of interest. The Kaplan experiment, which was designed to measure the vertical distribution of temperature between about 10 and 50 km by measuring long wave radiations from carbon dioxide in the earth's atmosphere, is also discussed.

18. Godson, Warren L., 1962: Problems of high atmosphere meteorology (condensed version) McGill Univ., Arctic Meteorology Research Group, Pub. in Met., No. 47, 1-8. (Complete text in IUGG Chronicle, Paris, No. 39, 261-282, Nov. 1961.)

Various meteorological characteristics of the high atmosphere are outlined with brief reasons and problems of general interest, such as vertical and horizontal velocities, turbulence, etc., as well as micro-, meso-, and macro-scales. The high level atmosphere characteristics can be analyzed with differential, simplified geostrophic and thermal equations with variables. High atmospheric composition is studied for presence of O_3, O_2 and O; NO, NO_2, and N; H_2O, OH and H_2 and Na. Problems on solar and infrared radiations are investigated with high balloons, meteorological rockets, large rockets and satellites. Observation technique and value of various parameters are briefly outlined. /MA/

19. Godson, Warren L., 1964: Meteorological rockets and the IQSY. Bull. Am. Met. Soc., 45 (3), 143-148.

20. Hanessian, J., Jr., and I Guttmacher, ed., 1958: Experimental results of the U. S. rocket program for the International Geophysical Year to July 1, 1958. IGY Rocket Report Series, No. 1. /R/

21. Hare, F. K., Chairman, 1964: Contributions to the seminars on the stratosphere and mesosphere and polar meteorology, July 7-19, 1963. Air Force Cambridge Research Laboratories, 244 p. AFCRL 64-197.

This report contains extended summaries of all the lectures presented at the meetings held at Stanstead in July 1963. Some summarize work already in print, and many contain material which has not yet been published. The summaries range over a wide variety of topics including polar micro-climatology, automatic data processing and computer applications to numerical weather prediction, atmospheric ozone, problems of atmospheric dynamics and energy and momentum studies, and atmospheric tides and gravity waves.

22. Harvard College Observatory, The Rocket Panel, 1952: Pressures, densities, and temperatures in the upper atmosphere. Phys. Rev., 88, 1027-1032. /R/

23. Heikkila, W. J., 1960: A summary and bibliography of high altitude rocket research between January, 1953 and July, 1958. Defence Research Telecommunications Establishment, Canada, DRTE Rept. No. 1040. /R/

24. Hesse, Walter, 1961: Geschichtliche Entwicklung der Aerologie und der Physik der freien Atmosphäre /Historical development of aerology and the physics of the free atmosphere/. In Hesse, Walter (ed.), Handbuch der Aerologie. Leipzig, Geest & Portig, 1-16.

A systematic but condensed outline of the history of the following aerological methods is presented: 1) mountain observatories; 2) free manned balloons; 3) recording balloons; 4) kites, captive and kite balloons; 5) pilot balloons; 6) airplane soundings; 7) radiosondes; 8) lighter than air craft and 9) meteorological rockets. The chronology of each of these systems is presented and in the case of rockets and satellites a tabulation of the satellites for 1957-1960 in the USSR and in 1958 and in the U.S.A. is presented. Finally a section on the highlights in aerological discoveries, including a list of the International Aerological Commission Sessions (1898-1935) is given. /MA/

25. Hord, Richard A., Wilber B. Huston, and Harold B. Tolefson, 1963: The atmosphere as a part of the space environment. National Aeronautics and Space Administration, NASA TN D-1387, 96 p.

A survey of the main features of the earth's atmosphere which define a portion of the near-earth space environment is presented in three parts entitled: I. Composition, Temperature, Density, and Pressure of the Atmosphere; II. Radiation Balance of the Earth's Atmosphere; and III. Winds and Motions in the Atmosphere.

26. Hulburt, E. O., 1955: Advances in the physics of the upper air since 1950. NRL Report 4600. AD 77 444. /R/

27. Inter-Range Instrumentation Group of the Range Commanders' Conference, 1961: Initiation of the meteorological rocket network, IRIG Document No. 105-60, Revised August. AD 246 950. /R/

28. Jacobs, Woodrow C., 1962: Meteorological satellites. Staff report prepared for the use of the Committee on Aeronautical and Space Science, U. S. Senate by the Library of Congress.

A careful review of the history of surface and upper air meteorology, culminating in the use of rockets and satellites in practical day-to-day meteorological work. The impact of the successful launching of Tiros I, April 1, 1960, on the future progress of both practical meteorology and theoretical research is forcefully presented. The international requirements and cooperation, the estimated costs of future programs, the national and international implications of meteorological satellites and the problems of interest to the U.S. Congress are thoroughly covered. Eight appendices give appropriate supporting data. The sixth of these appendices shows all the satellites carrying meteorological equipment launched up to the time of the preparation of this publication.

29. Jenkins, K. R., W. L. Webb, and G. Q. Clark, 1960: Rocket sounding of high atmosphere meteorological parameters. IRE Trans. on Military Electronics MIL-4, 238-243. /R/

30. Joint Scientific Advisory Group, 1961: The Meteorological Rocket Network: an analysis of the first year in operation (Report to the Meteorological Rocket Network). J. Geophys. Res., 66 (9), 2821-2842.

The operation of the Meteorological Rocket Network is reviewed and the equipment being used to collect wind and temperature data from the mesosphere (30 to 80 km) is briefly described. Sources of wind error in the sounding technique are discussed and evaluated as far as possible. Chaff (.012-inch nylon) has a very rapid response to the wind below 75 km, but the characteristics of the 15-ft parachute above 55 km have not yet been determined. Errors in tracking the parachute with FPS-16 or Mod II radars are of the order of 3 m/sec when the wind is averaged over 1 min. Time-height diagrams of the observed and seasonal mean wind velocities are presented for selected stations in the network. They demonstrate the winter and summer wind speed maximum at 50 to 60 km and the circulation reversal between summer and winter. The magnitude of the wind variability over short periods (of the order of an hour) appears to be height-dependent. Both speed and direction show greater variability at higher levels. Only limited temperature data were available but in the mean they show excellent agreement with the standard atmosphere up to about 50 km. Examples of the circulation over North America at heights up to 50 km are given for selected days during spring, summer and fall. In addition, 1-mb charts (~47 km) are presented for the winter of 1959-1960 and the summer of 1960.

31. Jones, L. M., 1959: Measuring upper-air structure. Astronautics, 4, 28, 29, and 50. /R/

32. Kalinovskiy, A. B., and N. Z. Pincus, 1962: Soviet aerological measurement. Joint Publications Research Service, JPRS 16691, 290 p. AD 299 217.

Contents:
1. Use of radar for aerological research. p. 1-87
2. Aerological methods of studying clouds. p. 88-136
3. Methods for investigating vertical motion and turbulence in the free atmosphere. p. 137-199
4. The use of rockets for atmospheric research. p. 200-276
5. Bibliography. p. 277-286 /STAR/

33. Kallmann Bijl, H., ed., 1960: Space Research, Proceedings of the First International Space Science Symposium, Nice, January 11-16, 1960. North-Holland Publishing Co., Amsterdam (Interscience Publishers, Inc., New York). /R/

34. Kiss, E., 1960: Annotated bibliography on rocket meteorology. Meteorological and Geoastrophysical Abstracts, 11 (9), 1480-1535. /R/

35. Kiss, E., 1961: Bibliography on upper atmosphere structure (general and 30-80 km). Meteorological and Geoastrophysical Abstracts, 12 (4), 776-827. /R/

36. Kiss, E., 1963: Bibliography on meteorological satellites (1952-1962). Meteorological and Geoastrophysical Abstracts, 14 (3), 870-936.

This annotated bibliography contains information on the following subjects: (1) general works - books, reports, bibliographies, etc.; (2) instrument carriers - satellites, space probes, rockets; (3) instruments; (4) observational methods and techniques; (5) parameters - atmospheric structure, composition, radiation; (6) weather observations - clouds, storms, etc.; (7) weather forecasting; and (8) programs and projects. /STAR/

37. Kondrat'yev, K. Ya., 1963: Meteorological investigations with rockets and satellites /Meteorologicheskiye issledovaniya s pomoshch'yu raket i sputnikov/. National Aeronautics and Space Administration, NASA TT F-115, 284 p.

This monograph considers methods and results of meteorological investigations with rockets and satellites. Methods for investigating the structure, composition, and dynamics of the upper atmosphere, and the possibility of utilizing artificial earth satellites for studying weather-forming processes in the troposphere and stratosphere are discussed. Modern information as to the composition, structure, and wind patterns of the upper atmospheric layers is given in detail, as are the results of investigations into solar and terrestrial radiation.

38. Kozakov, L. A., and V. A. Shtal', 1963: The stratosphere and mesosphere. Joint Publications Research Service, JPRS-21978, 11 p.

The structure and composition of the earth's atmosphere, especially the layers known as the stratosphere and the mesosphere, are discussed with regard to the importance they play in the determination of the temperature on the earth, their individual pecularities, and their role in aviation. The regular variation of the process in the stratosphere and the mesosphere is discussed, and more detailed studies of the upper atmosphere are recommended. /STAR/

39. Lion, K. S., 1959: Instrumentation in Scientific Research -- Electrical Input Transducers. McGraw-Hill, Inc., New York, 324 p. /R/

40. Maeda, Ken'ichi, 1963: Investigation of the upper atmosphere by rocket sounding. In Development of Sounding Rockets in Japan, NASA TT F-87, 97-109.

Upper atmospheric studies by sounding rocket are reviewed, and plans for future research are outlined. The observations made include ion density of the ionosphere, temperature distribution, wind direction, wind velocity, cosmic rays, solar radiation, and sound propagation. Future plans call for studies of the composition of the atmosphere, physical nature of the exosphere and ionosphere, field intensity and structure, and the electromagnetic spectra. /STAR/

41. Malone, T. F., ed., 1951: Compendium of Meteorology. American Meteorological Society, 1334 p.. /R/

42. Meteorological Office, Air Ministry, 1961: Handbook of Meteorological Instruments: Part II, Instruments for Upper Air Observations. M.O. 577, Her Majesty's Stationery Office, London. /R/

43. Middleton, W. E. K., and A. F. Spilhaus, 1953: Meteorological Instruments. Third Edition, Revised. University of Toronto Press. /R/

44. Mitra, S. K., 1952: The Upper Atmosphere. Second Edition. The Asiatic Society, Calcutta, India. /R/

45. Morris, James E., 1964: Conference on stratosphere-mesosphere structure. Bull. Am. Met. Soc., 45 (3), 149-150.

This article reports briefly on the conference program and topics discussed.

46. Murgatroyd, R. J., 1962: Atmosphere between 20 and 80 km. Australian Meteorological Magazine, No. 36, 30-36.

The present knowledge of the atmosphere between 20 and about 80 km is reviewed and the general circulation in this region discussed. From estimates of the distribution of ozone and molecular oxygen, the only significant absorbers of solar radiation between 30 and 100 km, and their absorption coefficients, the heating at each level has been calculated. The content of water vapor at about 15 km is rather small everywhere, but there is some evidence of a marked increase between 15 and 30 km, the source of which is uncertain. Carbon dioxide, ozone and water vapor are of importance in the long wave balance, and terrestrial radiation effects have been calculated from a knowledge of their distribution. From the above, the distribution of heat sources and sinks has been obtained. Mean cross-sections of wind and temperature from the equator to the poles have been prepared, consistent with the thermal wind equation. A description of these winds and temperatures is given. More recent meteorological rockets and other observations, particularly in the U.S., have shown the cross-sections as broadly correct, and have also made it possible to improve them.

They also give further insight into the "sudden warming" phenomenon of early spring. Information on the general circulation above 30 km is scanty. Mean meridional circulations between the tropopause and the mesopause levels have been calculated by Murgatryod and Singleton, using the equation for the rate of change of temperature of a moving particle and the equation for continuity. The frictional meridional components of motion, consistent with the curvature of the vertical profile of the mean zonal wind components, have been calculated by Haurwitz. There is fair agreement between these 2 models as regards the principal vertical motions, but not as regards the details of the meridional flow pattern. The type of circulation that may be expected from observations of tracer distributions has been worked out by some investigators. Further observations of wind, temperature and the factors affecting radiation and further theoretical work are badly needed for a complete picture of this region. /MA/

47. Naval Research Laboratory, 1957: History of the upper-air rocket-research program at the Naval Research Laboratory, 1946-57. Upper Atmosphere Report No. 32. AD 153 208. /R/

48. Newell, H. E., Jr., 1953: High Altitude Rocket Research. Academic Press, Inc., New York. /R/

49. Newell, H. E., Jr., 1955: Rocket data on atmospheric pressure, temperature, density, and winds. Ann. Geophys., 11, 115-144. /R/

50. Newell, Reginald E., 1964: The circulation of the upper atmosphere. Sci. Am., 210 (3), 62-74.

This is a general treatment of current meteorological knowledge of the atmosphere up to about 80 km.

51. Pan American World Airways, Inc., 1963: AMR instrumentation handbook, Vol. 1. Operational systems. Pan American World Airways, Inc., AFMTC TDR 63 1, V1. AF08 606 5300, AD-413 480.

The Atlantic Missile Range (AMR) extended from the eastern United States mainland through the Atlantic area and into the Indian Ocean to 90 degrees East longitude. Its resources include data acquisition, data processing, data reduction, timing, firing, frequency

control and analysis, and range safety systems, as well as range-wide communications. This book describes the major systems now operating, or being installed, on the Range. The equipment and operation of each system is described briefly, and its location and accuracies given.

52. Poloskov, S. M., and B. A. Mirtov, 1957: The study of the upper atmosphere by means of rockets, at the Academy of Sciences. USSR, J. Brit. Interplanet. Soc., 16, 95. /R/

53. Schotland, R. M., A. M. Nathan, E. A. Chermack, D. T. Chang, J. B. Neiger, and E. E. Uthe, 1962: Optical sounding. Technical Reports 1, 2, 3 and Final Report, New York Univ., DA-36-039-sc-87299.

Technical Report No. 1 under this contract is a survey of the literature pertaining to remote optical sounding of the atmosphere. Papers surveyed are categorized according to the following classifications;

1. Atmospheric optical properties
2. Atmospheric field measurements
3. Laboratory measurements
4. Sounding techniques
5. Instruments
6. Bibliography and surveys

Abstracts follow each paper of basic interest. (See also Schotland in humidity)

54. Slavin, R. M.; Kraff, L. et al., 1957: Atmospheric exploratory devices. In Handbook of geophysics for Air Force designers, ed. by C. F. Campen, Jr. et al. . . 1st ed., Ch. 20, 60 p.

Various devices for determining UV radiation, ionospheric currents, geomagnetic fields, chemical composition of atmosphere, pressure, temperature and density, winds, ion density, cosmic radiation, micrometeorites and airglow from rockets of various types are described and illustrated in outline form with many graphs and tables. Many types of surface barometers and their properties (accuracy, weight, availability, range, size, etc.), and also thermometers, radiometers, sunshine recorders, infrared detectors, psychrometers, hygrometers, wind instruments, ceiling, cloud, precipitation instruments, etc. and radiosonde, automatic and manual meteorological stations, sferics recorders, weather radar equipment, aircraft

measuring instruments of all types, rocket grenades, balloon equipment and their parameters, performance, launching equipment, etc. are treated in the text, illustrated photographically and graphically as well as given in tables. This is the most thorough review of meteorological instruments and their performance to date. /MA/

55. Stroud, W. G., 1958: Meteorological rocket soundings in the Arctic. Trans. Am. Geophys. Union, 39 (4), 789. /R/

56. Suomi, V. E., 1962: Observing atmosphere - challenge. Proc. IRE, 50 (11), 2192-2197.

Recent developments in aerospace technology make it possible to probe all regions of atmosphere; meteorological rockets, special observations from satellites and indirect probes discussed as examples. /EI/

57. Vassy, E., 1963: Revue sur la physique de la haute atmosphere, /Review of physics of the upper atmosphere/. International Symposium on Rockets and Satellite Meteorology, 1st, Wash., D.C., 1962, Proceedings, ed. by H. Wexler and J. E. Caskey, Jr., Amsterdam, North-Holland Pub. Co..

Attention is drawn to the necessity of separating the two main objectives: basic climatology and structure of disturbances. The data already obtained by using rockets are briefly summarized in the fields of pressure, density and temperature. It is shown that data are still missing above 70 km and for low latitudes. A tentative explanation of the higher winter temperatures above 60 km in polar regions is proposed. Concerning variable constituents of the atmosphere, O_3 is specially considered. It is pointed out that some blanks are not filled, specially for H_2O, N_2O, CH_4, CO, etc. Some results concerning the vertical distribution of aerosols recently obtained by German-French cooperation are presented. A table summarizing results in the wind field is given. The information brought by indirect methods is emphasized: anomalous propagation of sound, searchlights, meteors, ionospheric winds, etc. It is concluded that the use of rockets must avoid duplication, and bring confirmation of the methods and additional information.

58. Vorontsov, P. A., 1961: Metody aerologicheskikh issledovanii pogranichnogo sloia atmosfery / Methods of aerological studies of the boundary layer of the atmosphere /. Gidrometeoizdat., 220 p.

Various methods and apparatus adopted in the aerological investigation of the boundary layer of the atmosphere are described in detail and illustrated. The investigation includes the special studies of temperature, humidity of air, atmospheric pressure, wind conditions, turbulence and vertical currents. All described methods and equipment were tested by the author, with mathematical formulation of basic principles and evaluation of possible errors. The structure of the boundary layer is defined partly by processes occurring in free atmosphere and partly due to thermophysical and orthographical characteristics of layer near the ground. Therefore, special attention is given to the study of the boundary layer characteristics and effects of processes occurring in atmosphere. The book is composed of five chapters: (1) Sounding from aeroplane and helicopters; (2) Sounding from captive balloons; (3) Piloted balloon; (4) Special methods of investigation of the boundary layer (with kite, free balloon, parachute, radio controlled airplane and planner) and final 5th chapter on methods of processing of aeroclimatic observation data. Each chapter has description of method and apparatus with tabulated characteristics, data and general illustration corresponding instruments. Detailed construction and operation of major aerological instruments are described with diagramatic arrangement cross section, photographs and tabulated and graphically recorded performance characteristic data. The description covers the following instruments: radiosondes (various types), screened thermometers, psychrometers, accelerographs, meteorographs and radio meteorographs, and other instruments. / MA /

59. Webb, Willis L., Walter I. Christensen, Eldon P. Vainer et al., 1962: Inter-range instrumentation group participation in the Meteorological Rocket Network. Bull. Am. Met. Soc., 43 (12), 640-649. Also issued in Berlin. Freie Universität. Institut für Meteorologie und Geophysik, Meteorologische Abhandlungen, 36, 365-378, (1963).

From the inception of the Meteorological Rocket Network, the Meteorological Working Group of IRIG has been a convenient mechanism for coordinating the Network activities of the several participants. Upper atmospheric observation activities of the contributing agencies and projects have thus been coordinated to form the first synoptic-type study of the atmospheric region accessible only by rocket observation techniques. The Meteorological Rocket Network Committee (MRNC) has served as a forum for planning of studies, assimilating data on new developments in rocket vehicles, telemetry and sensing systems, and the distribution of the resulting data. The progress of the growing Meteorological Network is charted to date, and several of the applications of the resultant data are indicated. The impact of the Meteorological Rocket Network on the meteorological profession is discussed. / MA /

60. Wexler, H., 1961: Meteorological rockets and satellites. Trans. Am. Geophys. Union, 42 (1), 99-102.

The development in the U.S. of a network of synoptic rocket-sounding station has made the new technique of sounding the upper air with meteorological rockets very effective. The meteorologist now, also for the first time, has access to an observing platform in the earth-orbiting satellite. The significance of rockets and satellites, especially in the light of "Tiros" experiments for meteorological research, is outlined in this paper.

61. Wexler, H., and J. E. Caskey, Jr., eds., 1962: Proceedings of the International Symposium on Rocket and Satellite Meteorology, 1st, Wash., D.C., 1962. Cover-title: Rocket and satellite meteorology. "Sponsored by Committee on Space Research (COSPAR), World Meteorological Organization (WMO) and International Union of Geodesy and Geophysics (IUGG)," also: International Symposium on Rocket and Satellite Meteorology, 1st, Wash., D.C., April 23-25, 1962. COSPAR Information Bull., The Hague, No. 12, 7-15.

This volume contains 16 papers on meteorological rockets and 22 on meteorological satellites including 9 each on radiation and cloud studies and 4 on special studies. In the preface by Harry Wexler, he briefly outlines the developments which lead to the symposium and states that the 38 papers which include 5 presented at the 3rd International Space Science Symposium are published in this volume with the hope that they will contribute to better understanding of atmospheric phenomena and to wider employment of the powerful new tools made possible by the new Age of Space. A one page dedication by Sigmund Fritz entitled Harry Wexler and the ISRSM describes Wexler's interest in rockets and his role on convening the symposium. An author index and a photograph of Wexler complete this volume.

62. Wilckens, F., 1961: Bibliographie über Raketenmefsverfahren in der Stratosphäre und Mesosphäre. Flugwissenschaftliche Forschungsanstalt e.V. München, Institut fur Flugraumforschung, Berichte No. 11. /R/

63. Wilckens, F., 1962: Bibliographie über meteorologische Raketen und Satelliten sowie ihre Messergebnisse /Bibliography on meteorological rockets and satellites and results of their measurements/. Flugwissenschaftliche Forschunganstalt e. V., Munich, Berichte, No. 55.

This is a supplement to two previous bibliographies on meteorological rockets and satellites. The three reports (FFM-Berichte, No. 53-55) include 1150 publications on meteorological measurements conducted with the aid of rockets, and 450 publications on meteorological measurements carried out by means of satellites.

VEHICLES AND SOUNDING SYSTEMS

See also: Army Artillery Board (U.S.), 1961: Evaluation of radiosonde set AN/AMT-12. (353)

64. Air Force Air Weather Service, 1955: Accuracies of radiosonde data. Technical Report 105-133. AD 75 863. /R/

65. Air Force Proving Ground Command, 1956: Employment and suitability test of the AN/AMT-6 parachute radiosonde system. Final Report, Air Force Proving Ground Command, APG/SAC-248-A-1, 32 p. AD-293 959.

Employment and suitability tests were made of the AN/AMT-6 parachute radiosonde system, which was designed for obtaining, transmitting, and recording data pertaining to the temperature, pressure, and relative humidity of the atmosphere below the flight level of jet aircraft operating at high altitudes, and below conventional aircraft operating at low altitudes. The accuracy of the meteorological data obtained from AN/AMT-6 parachute radiosonde soundings was superior to that of the AN/AMT-3 parachute radiosonde and compared favorably with the accuracy of data obtained from AN/AMT-4 balloon-borne radiosonde soundings and routine weather charts; however, a high rate of AN/AMT-6 radiosonde failures was encountered. The AN/AME-1 dispensing set, which is employed in high-speed, high-altitude operations, was found to be unsuitable; also, in its present configuration the unit presents a safety-of-flight hazard. The mechanical defects and design deficiencies of the AN/AME-1 dispensing set are of such magnitude as to require major re-design of the item. The report concludes that the system, as tested, is not suitable for operational employment in high-speed, high-altitude aircraft. However, correction of the defects in the AN/AMT-6 parachute radiosonde will render the system suitable for use in low-speed, low-altitude operations.

66. Albrecht, H. J., 1956: New design aspects of Boomerang radiosondes for upper air research. Geofis. Pura e Appl., 33, 121-145. /R/

67. Alekseyev, P. P. and others, 1964: Investigation of upper atmospheric layers by means of meteorological rockets. In All-union Scientific Meteorological Conference; Proceedings. NASA TT F-168, I, 131-152.

This paper reports the measurement techniques employed on Russian meteorological rocket flights. Pressure measurements were made with diaphragm gages between 760 to 10 torr and with Pirani hot wire gages between 5 and 5×10^{-3} torr. Temperature was measured up to 80 km using thermistors. Density is calculated from measured pressure and temperature. The results of the measurements are also discussed.

68. Allen, J. W., and G. Welch, 1964: The lightweight transosonde system. Naval Research Laboratory, Report 5921, 139 p. AD 431 799.

A new lightweight transosonde airborne system has been developed. The new system, which consists of a lightweight plastic balloon and two small (1 cu ft) instrument packages, has been tested in a series of 50 flights over the Atlantic. After initial problems of balloon configuration and equipment limitations were resolved, a high percentage of successful flights was achieved.

The balloon is a pressurized sphere (12.5 ft diameter) made of 0.002-in.-thick Mylar plastic. It weighs approximately 20 lb and will withstand 50 to 60 millibars internal pressure. The instrumentation consists of:

1. A dual-frequency crystal-controlled 30-watt high-frequency transmitter.

2. A power supply consisting of a battery made up of silver zinc cells supplying the low dc voltage (7.5 v), and a dc-to-dc converter supplying the high voltage (300 v, 600 v).

3. A Morse code encoder and appropriate meteorological sensors (ambient pressure, ambient temperature, and balloon internal pressure).

The instrumentation is housed in two plastic (polyurethane) packages. Each package, including instrumentation, weighs about six pounds.

Since this equipment is expendable, it has to be economical in cost, yet provide maximum reliability during its operating life. Total cost of producing this equipment should not exceed $1000 per unit, and with proper flight preparation its useful life should be 10 to 15 days. In the research flight program carried on during this equipment development, flight duration was restricted to a maximum of 100 hours (four days) in order to avoid invading air space over the European continent. When properly utilized, this equipment offers a cheap, reliable means of meteorological data collection for extended periods, over large areas of the world.

69. Ashford, S. L., and W. P. Gleisner, 1964: Development of the AN/AMQ-21 multichannel radiosonde. Final Report, Bendix Corp., 79 p. AF 19(628)-2834, AFCRL 64-326, AD-602443.

The development of the AN/AMQ-21 continuous transmission multichannel radiosonde for use with Rawin Set AN/GMD-2 for meteorological soundings is described. Primary functions of the radiosonde are the measurement of slant range, temperature, humidity, and the provision for using an index of refraction sensor. It is a balloon-borne ground-launched device, transmitting all data simultaneously on a standard radiosonde carrier frequency. The report includes design considerations, descriptions of the radiosonde electronic system, discussion of associated antenna development, results of environmental and flight tests, and recommendations for additional developmental work. /STAR/

70. Atlantic Research Corporation, 1960: Flight testing of the Arcasonde I instrument package. /R/

71. Atlantic Research Corporation, 1962: Training manual, field and organization maintenance training, ARCAS rocket system. 226 p. AF 41(689)-785.

Contents:

1. Introduction to sounding rockets. 19 p.
2. Fundamentals of the ARCAS sounding rocket system. 30 p.
3. Transportation, handling, and field assembly. 14 p.
4. Assembly and operation of the launcher and auxiliary equipment. 23 p.
5. Loading and launching the rocket. 6 p.
6. Rocket instrumentation. 24 p.
7. The rocket launching site. 8 p.
8. Range coordination, safety, and count down procedure. 38 p.
9. Aerodynamics, performance prediction, and wind weighting. 44 p.
10. Maintenance and repair. 16 p.

Glossary of technical terms. 4 p.

72. Atlantic Research Corporation, 1964: The ARCAS, high-altitude sounding rocket system.

Brief descriptive brochure of the ARCAS vehicle and payloads.

73. aufm Kampe, H. J., and J. R. Walsh, 1960: USASRDL upper-air research with rockets. IRE Trans. on Military Electronics, MIL-4, 216-221. /R/

74. Baber, H. T., Jr., 1961: Performance and characteristics of several rocket systems for meteorological research. In Conference on the Status of Meteorological Rocketry, December 5-6, 1961, El Paso, Texas, Conference Program. /R/

75. Bauer, S. J., and J. E. Jackson, 1964: A small multi-purpose rocket payload for ionospheric studies. National Aeronautics and Space Administration, NASA TN D-2323, 18 p.

A miniaturized version of the two-frequency CW propagation experiment developed for ionospheric measurements uses small

(15 cm diameter) sounding rockets. The relatively high frequencies (24.5 and 73.6 Mc) for the propagation experiment permitted a very simple rocket antenna configuration. About half the Nike-Cajun rocket's payload space is occupied by the CW propagation experiment, leaving the rest available for one or two secondary experiments. Two telemetry channels are provided by modulation of the 73.6 Mc signal. A very high degree of frequency stability was provided in the two-frequency transmitter to permit Doppler radial velocity measurements at 73.6 Mc. The payload has been successfully flown on two Nike-Apache rockets, launched from Wallops Island, Virginia, late in 1962. The paper discusses the payload design, the flight performance, and the results of the ionospheric experiment. A new tracking method, using the CW propagation experiment, is also outlined.

76. Beach, C. J., 1963: A data link oscillator for use in a rocketborne meteorological dropsonde. Weapons Research Establishment (Australia), SAD-130, 12 p.

A data link oscillator working in the frequency range of 400 to 450 Mc has been developed for use in a rocketborne dropsonde for upper atmosphere research studies. This oscillator, after being satisfactorily subjected to environmental testing has been successfully flown in two high-altitude rocket trials. /STAR/

77. Bean, B. R., and E. J. Dutton, 1961: Concerning radiosondes, lag constants, and radio refractive index profiles. J. Geophys. Res., 66 (11), 3717-3722. /R/

78. Bellamy, J. C., R. F. Bosshart, C. A. Hermanson, and R. S. John, 1958: Investigation of the feasibility of acoustic soundings of the atmosphere. Final Progress Report, Cook Electric Company, FPR 152-1. AD 210 659. /R/

79. Belyayev, V. P., N. K. Vinnichenko, and L. A. Pakhomov, 1963: Electrometeorograph for helicopter (VEM). Air Force Systems Command, Foreign Tech. Div., FTD-TT63-632, 19 p. AD-414 990.

80. Bendix Aviation Corporation, 1959: Final report AN/AMQ-15 air weather reconnaissance system, feasibility study of index of refraction expendable sensor for rocketsondes and dropsondes, phase 1, Report No. 1319. /R/

81. Bendix Corporation, 1962: Cricketsonde meteorological rocket and instrument package. The Bendix Corporation, Pub. EIR 448, 7 p.

The "Cricketsonde" is a recoverable radio telemetering instrument designed to be carried aloft by a cold propellent "Cricket" rocket which descends from altitudes of about 3000 feet by a self-contained parachute, at a rate of 600 feet per minute. Nominal range of the meteorological sensing elements is as follows: pressure from 1060 to 840 millibars, temperature from plus 50°C to minus 20°C, and relative humidity from 10 to 100 percent. The temperature sensor is ML405/AM thermistor element, accuracy ±0.5°C, temperature resolution ±0.25°C. The humidity element is standard ML-476/UM carbon coated element. The aneroid pressure sensor has a stated calibrated accuracy of ±2 mb.

82. Berg, Hellmut, 1961: Aerologische Flugzeugaufstiege /Aerological airplane ascents/. In Hesse, Walter (ed.), Handbuch der Aerologie. Leipzig, Geest & Portig, 282-380.

A major and exhaustive review of the entire field of airplane soundings and meteorological observations using airplanes. The advantages of airplane observations over balloon or kite observations, the organization of the airplane weather service and types of flights (vertical or semihorizontal) history of weather flights (since 1912), organization of an airplane observation station, types of weather planes (including hurricane reconnaissance planes) measurements of pressure, temperature and humidity with various types of airplane meteorographs, Raethjen's photometeorograph, ventilation, mounting evaluation of records, corrections for airplane speed, etc.; miscellaneous measuring devices for mounting on or in airplanes - especially electrical devices, frost point thermometers; analysis of curves made from data; eye observations by pilots or observers, wind drift measurements from planes (over cities and over ocean such as in hurricane reconnaissance) weather maps made from airplane reconnaissance flights over Pacific; special observations of clouds, precipitation, optical phenomena, visibility blueness of sky, lumpiness, diffusion; wind shear; instruments for measuring water content of clouds, icing, turbulence, drop size distribution, radiation, cloud photography, synoptic studies of cloud systems from airplane reports, fronts, cross sections, albedo measurements, organic matter in air (pollen, allergies, insects), salt content of air, and finally the possibilities for future use of aircraft in meteorological observations. The first part of the review is mainly concerned with German work up to the W. W. 2, the text pertaining to U. S. and

British developments since the war. An excellent bibliography is appended and numerous examples of records, synoptic charts, cross sections, line drawings, curves, data and photos included. / MA /

83. Berning, W. W., 1961: Rockets for use in upper atmosphere research. North Atlantic Treaty Organization. Advisory Group for Aeronautical Research and Development, Report 383, 26 p.

The atmospheric and geophysical properties of the atmosphere over 100 km and their methods of measurement are discussed, with particular emphasis on the interaction of the sounding vehicle with the properties being measured. The economics of rocket sounding including considerations of trajectories, altitudes, vehicle speed and geographical location are discussed. A list of papers presented at the AGARD Specialists meeting on "The use of rocket vehicles in flight research," Scheveningen, Holland, July 1961, with the AGARD Report number is also given in an addendum. / MA /

84. Blackburn, C. P., and D. B. George, 1964: Air launched rocketsounding study. Final Report, The Bendix Corporation, EIR-549, 144 p. AF 19 (628)-3264, AFCRL-64-127, AD 600 400.

The results of a program to study, evaluate and recommend the most feasible techniques and equipment for an air launched rocket sounding system compatible with the AN/AMQ-19 meteorological system are presented in this report. The purpose of the rocketsounding system is to extend the meteorological data envelope to an altitude of 120,000 feet and to provide a growth capability for future expansion to 250,000 and the area between 400,000 and 600,000 feet.

Several approaches to air launched meteorological soundings have been studied. These include various air-frame installation configurations, rocket propelled flight vehicles, and a gun launched meteorological probe. The various factors involved in the program; Aircraft Flight Safety, installation, rocket vehicle configuration, meteorological instrument package, and system growth potential have resulted in the recommendation of one configuration as the optimum. These vehicles, carried in underwing external stores, are readily adaptable to either the W-47B or KC/C135B aircraft.

The sounding vehicle will be dropped from the aircraft, parachute stabilized and sequence fired to attain the desired 120,000 foot level. At apogee, the instrument package will separate from the vehicle and transmit pressure, temperature and humidity data. A control pressure capsule within the sonde will terminate the RF signal when it has descended to aircraft flight level. This cut-off permits optimization of instrument descent rate and precludes aircraft maneuvers to maintain data reception from the sonde. The vertical profile may be continued to ground level with an AN/AMT-13 radiosonde which is an integral part of the AN/AMQ-19 system. Density of the air through which the sonde passes may be calculated by use of the temperature, pressure and altitude data obtained for the 120,000 and 250,000 foot systems as air may be considered as having a constant molecular weight at these altitudes. Functional descriptions of the AN/AMQ-19 and AN/GMH-4 systems have been included in this report, along with a description of the compatibility of the rocketsounding system. The incorporation of an available aircraft qualified rocket motor in the flight vehicle will contribute to reduction of cost during development and qualification of the system.

85. Brown, G. F., 1961: Report of project No. FA 760, evaluation of radiosonde set, AN/AMT-12. U.S. Army Artillery Board, Headquarters. /R/

86. Clark, G. Q., 1961: Development of a rocket telemetry package for the meteorological rocket network. In Initiation of the meteorological rocket network, Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised, p. 117. /R/

87. Cline, D. E., 1958: Rocket atmospheric sounding system (RASS). U. S. Army Signal Research and Development Laboratory, USASRDL TR-1960. /R/

88. Coppola, A. A., 1958: Parachute radiosonde system (AN/AMT-6, AN/AMR-1). U.S. Army Signal Research and Development Laboratory, USASRDL TR-1971. /R/

89. Coppola, A. A., 1961: A rocket-type ranging and telemetry system. In Initiation of the meteorological rocket network, Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised, p. 143. /R/

90. Coppola, A. A., 1963: Radiosonde Set AN/DMQ-6. Army Electronics Research and Development Laboratory, AELRDL TR-2354, 35 p. AD 408 325.

Engineering flight tests were made on a system which included Radiosonde Set AN/DMQ-6, the ARCAS rocket, and Rawin Set AN/GMD-2. Temperature data were obtained with rod thermistors and bead thermistors. Data were obtained on a high-altitude hypsometer pressure sensor under development. Wind data were obtained and evaluated, and altitude data derived from the AN/DMQ-6 and Rawin Set AN/GMD-2 were compared with those obtained with the AN/FPS-16 radar. The altitude layer over which the data were obtained was between 80,000 and 210,000 feet. The test procedure used was that described in USASRDL Technical Report 2171.

Analysis of data obtained indicates useful temperature- and wind-data to 190,000 feet. Altitude data showed agreement within one percent or better with radar data.

91. Court, Arnold, and Henry Salmela, 1962: Measurement range required of meteorological equipment. Air Force Cambridge Research Lab., Instrumentation for Geophysics and Astrophysics No. 22, 11 p. AFCRL 62-825, AD-285 018. (See also: AFCRL-62-825, Supplement 1, February 1963, 2 p. AD 404 227.)

Meteorological instruments must operate properly to accurately measure conditions too extreme for the design and operation of other equipment. This report develops the 'improbable extreme' conditions which surface instruments must be designed to measure; temperatures from −140 F to +160 F, dewpoint at any temperature, T in deg F, given by T/2-80, rainfall during t minutes square root of t divided by 2 inches, wind speeds up to 250 mph, and pressure from 506 to 1062 mb. Atmospheric sounding systems must be able to measure temperatures and corresponding dewpoints over the same range, winds up to 300 mph below 100,000 ft, and pressures whose ratio to the Standard Atmosphere pressure, p, at the maximum height they are expected to attain, is 0.1 (6+ log p) up to 133 km, and 0.1 at still higher levels.

91. Davis, Howard, and Seymour S. Shefter, 1950: Study of single station atmospheric sounding system, Volume I. U.S. Signal Corps. Engineering Laboratories, Technical Memorandum M-1341, 115 p.

The standardization of the rawin set AN/GMD-1 and associated equipment for field use in determining wind speed and direction, temperature and humidity of the atmosphere at all levels is discussed and compared with other systems and techniques (remitter, radar, Fledermaus, slant range-pressure, radar-remitter, etc.). In connection with standardization the research and study programs are developed for determining: 1) meteorological parameters; 2) accuracy of significant parameters; 3) variation of parameters with time and space; 4) adjustment of accuracy with required reliability and 5) capabilities of meteorological, electronic and other instrumentation techniques to be applied. Various methods determining meteorological elements (pressure, temperature, humidity) are discussed with consideration of present and future developments in methods and instrumentation. Types of Single Station Atmospheric Sounding Systems (SSASS) are described in detail with comments on their physical characteristics, accuracy of measurements affected by altitude and meteorological elements expressed in numerical values. The factors affecting the design characteristics of the SSASS are accounted separately (time and space, curvature of the Earth, atmospheric refraction, rate of ascent of meteorological balloons, etc.). Six appendices contain separate discussions of theoretical problems related to accuracy of the system and, finally, 21 charts and 19 tables with data are attached to the memorandum. /MA/

92. Dettwyler, H. R., R. T. Boerem, and J. E. Tobin; Roksonde-meteorological rocket progress in synoptic data link system. Marquardt Corp., MP 1010, 18 p.

93. Devyatova, V. A., 1963: High-altitude probing of the atmosphere on the IL-28 airplane. Air Force Systems Command, Wright-Patterson AFB, Foreign Technical Div., FTD TT-63-534, 16 p. AD-415 017. (Also: Library of Congress Aerospace Information Division T-63-54, 13 p. AD-403 013.)

The article is devoted to a new kind of aircraft probing of the atmosphere. A description is given of the equipment of the high-altitude probing aircraft IL-28, its system of flying, the observations in flight, and the particulars of the working of the recording tape of K4-51 automatic optical recorder.

94. Diamond, H., W. S. Hinman, Jr., and F. W. Dunmore, 1938: A method for the investigation of upper-air phenomena and its application to radio meteorolography. J. Res. NBS, 20, 369-392. /R/

95. Durasov, N. G., 1963: Wind protection for radiosonde balloons. Air Force Systems Command, Foreign Technology Div., FTD TT-63-708/1&2, 5 p. AD-416774.

A device to provide wind protection for radiosonde balloons during launching is described. During inflation and deflation the device is in the shape of an ellipsoid; its asymmetrical halves are constructed from metallic (e.g., duralumin) tubes bent in the form of an arc. The lower half of the ellipsoid has a thick elastic material stretched over it and is rigidly fastened to a collar that has an opening for the balloon to extend through. The upper half of the ellipsoid is covered with a thin material and is fastened, hinge fashion, to a similar collar. /STAR/

96. Dymond, E. G., 1947: The Kew radiosonde. Proc. Phys. Soc. London, 59, 645-666. /R/

97. Elam, W. W., 1961: ARCAS. In Initiation of the meteorological rocket network, Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised, p. 77. /R/

98. Faust, Heinrich, 1961: Forschungsraketen /Research rockets/. Naturwissenschaftliche Rundschau, 14, 149-150.

The progress in the development and use of research rockets by various countries is summarized. The properties and research capability of the U.S. Loki rocket, the ARCAS rocket and the Aerobee rockets are discussed briefly. In connection with IGY programs the U.S.S.R. has released 175 research rockets up to heights of 100 to 500 km. Of these 158 were for meteorological research and 17 for geophysical measurements. The French rocket, the Veronique, the Italian rocket operations in Sardinia, the "Kappa" research rocket of Japan, the "Black Bart" of Canada, the Swedish, Norwegian and Australian work with research rockets are also discussed. The research rocket network in the United States organized by H. aufm Kampe is described. /MA/

99. Fisher, H. F., Jr., E. B. Glover, and A. W. Vernon, 1961: Telemetry transducer handbook. Seventh Monthly Progress Report for period ending December 15, 1961, Radiation Incorporated. AD 268 851. /R/

100. Forbes, F. W., 1962: Expandable structures for aerospace applications. Aeronautical Systems Div., Flight Accessories Lab., presented to the British Interplanetary Soc., 1 May 1962, 137 p.

This paper discusses the history and the future of expandable structures in space applications. This discussion covers the areas of inflatable balloons, rigidized balloons, Goodyear airmat foamed-in-place, expandable honeycomb and unfurlable structures in the areas of concept description, actual applications, materials, generalized design procedures, future applications, advantages, and the disadvantages of each system. It is pointed out that there is no one universal expandable structure system that will meet the requirements of all applications. However, recommendations are made concerning specific applications for each of the above-mentioned six concepts, it is concluded that expandable structures definitely do have a role in future space applications. /STAR/

101. Frey, W. M., 1961: A rocket borne sunfollower. Ballistic Research Laboratories Memorandum Report No. 1364. AD 265 588. /R/

102. Giraytys, James, and Harold R. Rippy, 1964: The USAF meteorological rocket sounding network: present and future. Bull. Am. Met. Soc., 45 (7), 382-387.

Past efforts in meteorological rocket sounding systems are reviewed to show how the current USAFMRN evolved. The capability of the USAFMRN is analyzed with respect to its ability to satisfy current requirements for data. The expansion of the network is predicted, based upon stated and anticipated needs and the status of meteorological equipment under development.

103. Goyer, G. G., and R. Watson, 1963: The laser and its application to meteorology. Bull. Am. Met. Soc., 44 (9), 564-570.

This article reviews recent developments in laser technology, discusses characteristics of the laser beam and shows how those

characteristics might be employed in meteorology. The need to choose particular wavelengths for use for different meteorological studies is emphasized. The laser has theoretical promise for meteorology but many problems remain to be solved.

104. Grass, L. A., 1962: Superpressure balloon for constant level flight. Air Force Cambridge Research Labs., Instrumentation for Geophys. and Astrophys. No. 21, 73 p. AFCRL 62-824.

Superpressure balloons are highly stable platforms for long-duration experiments in the stratosphere, capable of remaining at constant-density altitude, without ballast, despite diurnal fluctuations in "superheat" of the lifting gas. Duration is theoretically limited only by eventual deterioration of the plastic or loss of gas by permeation. Equations relating superpressure, superheat, and free lift are derived. Developmental problems, design, cold-chamber testing, and relative merits of cylinder, tetrahedron, onion, and sphere are discussed. Flight data confirm capability of laminated-Mylar spheres with preformed end caps and bitape seals. /STAR/

105. Guard, George C., 1963: Balloon performance at high altitudes. Bull. Am. Met. Soc., 44 (12), 778.

The author points out that the Kaysam Corporation of America has for the past 2 years been supplying a production balloon weighing about 166 gms to the U. S. Army and Air Force. This balloon attains altitudes exceeding 100,000 ft. Recent improvement in balloon manufacture by the company has resulted in balloons that reach altitudes of 110,000 ft.

106. Haig, Thomas O., and Vincent E. Lally, 1958: Meteorological sounding systems. Bull. Am. Met. Soc., 39 (8), 401-409.

A survey is presented of past and present systems for obtaining direct measurements of atmospheric wind, pressure, temperature, and water vapor. Estimates are included of the types of horizontal- and vertical-sounding systems which will be in field use within the next decade.

107. Hall, F., 1950: Communication theory applied to meteorological measurements. J. Met., 7 (2), 121-129. /R/

108. Hetrich, G. R., 1963: Meteorological tracking radar study. Final Report, Bendix Corporation, 122 p. AF 19(628)-2499, AFCRL-63-766, AD 423 612.

The purpose of the study is to investigate the technical and economic suitability and availability of the existing tracking radars for use with the Robin and Rose meteorological balloon targets. The investigation is concentrated on the more stringent requirements of the Robin balloon. The study presents a discussion of the problem, the analysis of system errors, and an examination of the existing radars. It is recommended that a relatively inexpensive radar consisting of the Prelort Pedestal and Servo System be used in conjunction with specially tailored transmitter and receiver subsystems for a network of high-altitude research and data gathering centers. The report suggests modifications to the Prelort radar and to the balloon. An examination of the present Robin tracking technique is also discussed.

109. Hildner, Ernest G., 1963: Instrumentation of experiments for remote microwave probing of the atmosphere. National Bureau of Standards, NBS Report 7698.

Two radiometer systems are proposed to instrument the experiments proposed in NBS Report 7682. Comments are made on the suitability of maser preamplifiers and various antenna types for these experiments.

110. Hirao, Osamu, and Tomo Okamoto, 1963: The Rockoon. In Development of Sounding Rockets in Japan, NASA TT F-87, 55-74.

The program to launch sounding rockets from balloons (Rockoon) is outlined, and the problems encountered are discussed. While no actual flights were made, dummy launching tests have shown that under favorable climatic conditions a rockoon can be launched safely and reliably. /STAR/

111. Höhn, R., and R. Weide, 1960: Über den Streufehler der Freiberg-Sonde /Dispersion errors of the Freiberg radiosonde/. Z. Met. 14 (3), 79-84.

A series of twin ascents was evaluated to show the dispersion errors of pressure, temperature, and humidity recordings of the Freiberg-type radiosonde. The accuracy of these measurements was found to meet the operational requirements for radiosonde ascents. /MA/

112. Itokawa, Hideo, 1961: Developments of Project Kappa in 1959-60. International Symposium on Rockets and Astronautics, 2nd, Tokyo, 1960, Prcceedings, 146-157.

Kappa-6 developed by Sounding Rocket Team of Tokyo University, served for rocket sounding of temperature, wind, cosmic rays, pressure and solar radiation. The design of Kappa-6 was outlined and presented in pictures and diagrams. A new single tage Kappa-7 was used for flight tests of a new booster 420B and as sounding rocket with a higher payload of 20 to 40 kg. A two-stage rocket, Kappa-8 was to study the stability characteristics with the second stage rocket. Finally, a three-stage rocket Kappa-9 is projected; it will be a combination of Kappa-6 and Kappa-7. The peak altitude at vertical launching will be roughly 400 km.

113. Itokawa, Hideo, 1963: From the Pencil rocket to the Kappa-8. In Development of Sounding Rockets in Japan, NASA TT F-87, 28-54.

The development of sounding rockets in Japan is reviewed beginning with the Pencil rocket in 1955 and progressing through the Kappa-8 rocket in 1959. These are solid propellant rockets ranging in size from 23 cm to 10,032 cm. The problems occurring during this development period are discussed. /STAR/

114. Ivins, Albert, 1964: Rocket radiosonde AN/DMQ ( ) (XE-1); four-channel parallel telemetry sonde. U.S. Army Electronics Research and Development Laboratory, TR-2382, 39 p.

115. Keegan, T. J., 1961: Meteorological rocketsonde equipment and techniques. Bull. Am. Met. Soc., 42 (10), 715-721. /R/

116. Kidd, K. W., 1963: Continuation of the development of the AN/DMQ-9 rocketsonde. Bendix Corporation, 41 p. AFCRL-63-841, AF 19(628)-1655.

Included is a discussion of laboratory investigations of 1689 megacycle antennas, blocking oscillator circuits, and spin and acceleration effects on the instrument package. Flight test performance is presented. /STAR/

117. Kidd, S., 1964: Scientific ballooning. Industrial Research, July-Aug., 26-31.

The article discusses the recent increase in interest in the large gas filled balloon for use in scientific studies of the air layer up to 150,000 ft. The role of the National Scientific Balloon Flight Center in Palestine, Texas, is described. Development in balloon inflation techniques and in balloon materials and capabilities are detailed.

118. Lenhard, R. W., Jr., 1959: Meteorological accuracies in missile testing. J. Met., 16 (4), 447-453. /R/

119. Ludlam, F. H., and P. M. Saunders, 1958: Comparison of aerological soundings made simultaneously by radiosonde and aircraft. Tellus, 10 (1), 83-87. /R/

120. Mac Cready, Paul B., Jr., and Henry R. Jex, 1964: Study of sphere motion and balloon wind sensors. Meteorology Research, Inc., MR 164-FR-147, 46 p. NASA TM X-53089. NAS8-5294.

Balloons ascending in still air typically exhibit lateral movements that introduce errors when the ballons are tracked as sensors of wind motion. This report examines some of the fundamentals of the fluid flows and associated motions and net drag coefficients of free-moving spheres. The flows and motions depend directly on Reynolds number (R_d), which determines the flow regime; on the relative mass of the sphere to the fluid it displaces (RM) because, for a given R_d, the lower the RM values the greater the lateral motions and thus the larger the total wake size and drag; and on the sphere rotational inertia and minute details of surface roughness, sphericity, and random orientation. Because of these complex interactions no unique drag coefficient (C_D) vs R_d curve can be found for free-moving spheres. The separate effects of the main factors are described as they might affect an idealized C_D vs R_d curve for a perfectly smooth free-moving sphere of infinite RM. /STAR/

121. Malet, L. M., 1954: Diverses expériences de comparaison de radiosondes, Organisation Météorologique Mondiale, Genève, Note Technique No. 5. /R/

122. Mantis, Homer T., and William F. Huch, 1959: Meteorological studies using constant altitude balloons. Minnesota Univ., School of Physics, Technical Report AP-14. Nonr 710(22).

Contents:

1. Huch, W. F., Constant level balloon system for meteorological research, p. 1-6.
2. Mantis, H. T., Some observations of the structure of the upper winds at intermediate scale, p. 7-21.
3. Mantis, H. T., Studies of the relationship between the synoptic pressure field and the constant altitude balloon trajectories, p. 22-56.

Paper by Huch described the constant level balloon system used for precise altitude control trajectories. Papers by Mantis summarize information on wind structure in the intermediate scale and give analyses of data and trajectories, and review the work so far completed on the relationship between the synoptic pressure field forces and constant altitude balloon trajectories. The immediate applications of the results are in solving balloon trajectory forecasting problems, in the direct measurements of the effect of wind relationship with pressure field. Trajectories analyzed and illustrated are for Moby Dick flights released in Minnesota in Jan., March, Oct. and Nov. 1954.

123. Marks, S. T., L. C. MacAllister, J. W. Gehring, H. D. Vitagliano, and B. T. Bentley, 1961: Feasibility test of an upper atmosphere gun probe system. Ballistics Research Laboratories Memorandum Report No. 1368. /R/

124. Marquardt, J. F., W. A. Kerbs, R. L. Orr, M. P. Monson, and E. S. Fishburne, 1960: A study of methods for measurement of atmospheric parameters at supersonic speeds. Booz-Allen Applied Research, Inc., WADD TR 60-524. AD 241 052. /R/

125. Masterson, John E., 1961: The LOKI meteorological rocket system. In Initiation of the meteorological rocket network, Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised, p. 85. /R/

126. Masterson, John E., 1964: The strato-mesospheric meteorological rocket. In Meteorological Observations above 30 Kilometers, NASA SP-49, 1-13.

A discussion of the small solid propellant sounding systems and instrumentation that have been used to measure the atmospheric structure from 30 to 60 km (100,000 to 200,000 ft). These systems are examined with respect to the vehicle, the sensors, and data retrieval. With the state of the art in mind, the future rocket systems are explored.

127. Meszaros, Agnes, 1960: A Väisälä-tipusú magyar és az A-22 III tipusú szovjet rádiószonda adatainak összehasonlitása a Budapesten végzett kisérleti fölszállások alapján /Comparison of aerological data obtained by the Hungarian made radiosonde of the Väisälä type and by the Soviet radiosonde type A-22 III, through experimental ascents at Budapest/. Országos Meteorológiai Intézet, Hivatalos Kiadványai, No. 24, 17-25.

Owing to the fact that, in our aerological service, the two types of radiosondes are used alternatingly on a routine basis in daily operational work, the necessity arose of undertaking comparisons between results obtained by the two kinds of instruments. It was fou , by means of 24 experimental ascents, that the data of atmospheric pressures, temperatures and humidities are, on the average, in a rather good agreement, with the exception of temperature data measured at noon, the Hungarian sonde possessing, in this case, a greater radiation error which leads to considerable discrepancies. /MA/

128. Middleton, W. E. K., 1946: The present-day accuracy of meteorological instruments. Quart. J. Roy. Met. Soc., 72 (1), 32-50. /R/

129. Mitra, H., 1961: Electronic radiosonde of continuous telemetering type. Indian J. Met. Geophys., 12 (2), 327-334.

A description of an electronic radiosonde of the continuous telemetering type which was developed in the India Meteorological Department and is now being subjected to rigorous tests. Details are given on the principle of the electronic radiosonde, the balloon-borne equipment, the receiving equipment, the frequency counting system and the recording system. Illustrations are included: circuit diagram of the radiosonde, block diagrams of balloon equipment, receiver frequency measuring and frequency recording equipment. Photographs of the components and the complete radiosonde are included.

130. Myers, Robert F., 1962: Vertical soundings of the atmosphere. Bull. Am. Met. Soc., 43 (9), 467-474.

The author reviews the progress achieved in operational sounding systems in the past decade with particular reference to the instrumentation and the techniques used. The possible areas for improvement are examined, viz.: sensors such as head thermometers for temperatures above 10,000 ft; a thermoelectric dew pointer; telemetry and tracking techniques for upper air sounding based upon special coding and modulation systems which conserve bandwidth and power; rocket-borne sondes, etc. Comparative costs of various developments are examined and a program of design goals is outlined. /MA/

131. Myers, Robert F., 1963: Meteorological telemetry. Presented at the IEEE Summer General Meeting and Nuclear Radiation Effects Conference, Toronto, Ont., Canada, June 16-21. IEEE No. CP- 63-1067, 13 p.

This paper summarizes for the non-meteorologist the telemetry techniques being practiced by the meteorological profession.

132. National Center for Atmospheric Research, 1964: Symposium provides clues to balloon failure. Scientific Ballooning, No. 17, 12 p.

Discussion of possible reasons for failure of high altitude balloons as a result of rupturing near the top. Possible remedies including reinforcing the top or preventing the balloon from oscillating while rising are suggested.

133. Naval Ordnance Laboratory, 1957: Feasibility of a meteorological rocket for synoptic measurements to 300,000 feet. Prepared by the HASP V Committee: Auld, C. D., E. H. Hurlburt, J. L. Jones, Chairman, J. M. Kendall, D. W. Sencenbaugh, H. W. L. Street, and D. R. Williams, NAVORD Report 5761. /R/

134. Neaga, Vadim Gh., and V. V. Neaga, 1960: O noua conceptie de baza pentu schemele radiosondelor, statiunilor meteorologice automate si rachetelor de cercetari /New basic concept for the design of radiosondes, automatic weather stations and research rockets/. Bucharest. Universitatea, Analele Stiintifice, n.s., Sec. 1, Matematica, Fizica, Chimie, 7 (1), 217-220.

The authors describe the functioning of a variety of complex instruments used for collecting meteorological data for parameters varying with height. Emphasis is placed on the fact that any such device (radiosondes, rockets, etc.) usually needs a very complicated and cumbersome transmitter, with quite limited range, since at the receiving end the separation of the signals, their deciphering is entrusted to man, hence is exposed to numerous errors. To correct all these drawbacks, the authors suggest the simultaneous use of amplitude and of frequency modulation, in addition to the variable duration of the electrical signals. The variable duration (time-wise) of the signals would depend on a third factor studies. The expression "modulation" thus refers to the undulating wave; the carrier (wave) and the transmitter continue to operate on the principle of amplitude modulation. The authors conclude that their method will make possible the use of a simplified transmitter; smaller volume and weight, and cost. It will allow an almost continuous transmission of data. Although it will require a more elaborate and complete receiving station, the human element will be eliminated. /MA/

135. Nelson, Eric, 1964: Neoprene elastomers for balloon fabrication. Second Quarterly Progress Report, 1 Jun.-31 Aug. Kaysam Corp. of America, 48 p. DA 36-039-AMC-03737(E), AD-450852.

The following topics are presented: "Evaluation of Neoprene Polymers" - physical properties determined of films obtained by dipping in dry neoprene solutions: "Evaluation of Other Raw Materials" - antiozonants and antioxidants, and plasticizers; "Evaluation of Processing Techniques"; "Investigation of Balloon Film Structure" - photomicrographs of uncompounded and compounded neoprene films; "Correlation

of Balloon Flight Performance and Compound Properties" - balloons made from compound A5-101 reaching altitudes of more than 130,000 feet, and good results with balloons from a standard dual-purpose compound, but cured at lower than normal temperatures; "Correlation of Atmospheric Parameters and Compound Properties" - ozone flights analyzed according to performance, and relationship determined between bursting altitude and ozone concentration at various levels. /STAR/

36. Nelson, E., and J. Kantor, 1961: Design, development, and production of meteorological balloon, capable of ascents to altitudes in excess of 120,000 feet during the day and night. Final Report on work done April 20, 1960 to July 15, 1961, Kaysam Corporation of America. DA-36-039-SC-84926, AD 260 554. /R/

37. Nelson, E., and J. Kantor, 1961: Study of physical and chemical characteristics of balloons and balloon materials. Report No. 5, April 25, 1961 to July 24, 1961, Kaysam Corporation of America. DA-36-039-SC-84925, AD 262 540. /R/

38. Nelson, E. and H. Newstein, 1964: Study of physical and chemical characteristics of balloons and balloon materials. Final Report, March 1, 1963-February 29, 1964, Kaysam Corporation of America, 148 p. DA-36-039-AMC-02160(E), AD 601 997.

Work was conducted on the following tasks: TASK A - PROPERTIES OF BALLOONS AND BALLOON FILMS. The current literature was reviewed, and several neoprene polymers as well as polyisoprene and natural latex were examined. Plasticizers, accelerators, and fillers were also examined. A number of compounds having properties superior to those already in existence were designed; and as a result, higher altitudes were obtained in each balloon size. A compound which produces balloons capable of flight at night in the Arctic as well as in the Tropics was designed. Compounds were also designed to produce faster rates of ascent. The effect of filtering balloon compounds was studied, and a series of photomicrographs of balloon films were obtained which showed the size of particles in the balloon film. TASK B - EFFECT OF FLIGHT CONDITIONS ON BALLOON PERFORMANCE. The effect of pre-elongation, ozone, and infrared radiation on balloon films was examined; and the behavior of balloon films exposed to atomic ozygen generated from hydrogen peroxide was investigated.

139. Nepomniashchii, S. L., 1958: Samoletnaia distantsionnai meteorologicheskaia stantsiia / Air-borne remote monitoring stations /. Leningrad. Nauchno-Issledovatel'skii Institut Gidrometeorologicheskogo Priborostroeniia, Trudy, No. 6, 39-65.

The air-borne station is installed on weather surveying airplanes for measuring air pressure (1050-250 mb), air temperature (+40 to -60°C), air humidity at dew point (35 to -60°C) and wind velocity.

140. Nordberg, William, 1964: Rocket soundings in the mesosphere. In Meteorological observations above 30 kilometers, NASA SP-49, 35-57.

This paper treats the meteorological and engineering aspects of the rocket sounding in the vicinity of 90 km (300,000 ft). These observations employ two-stage solid propellant rocket systems and are based on the sodium vapor, the acoustic grenade, the falling sphere, and the pitot-static tube experiments which were introduced and performed successfully for the International Geophysical Year. The results of these experiments and the physical characteristics of the mesosphere are discussed. / STAR /

141. Papai, László, 1960: Rádiószonda szerkezetek / Radiosonde mechanisms /. Országos Meteorológiai Intézet, Hivatalos Kiadványai, No. 23, 42-56.

The author gives a classification of the radiosondes and within this a survey of the different radiosonde mechanisms, measuring elements and their development, and discusses also shortly the general defects of barometers, thermometers and hygrometers. Mechanisms of radiosondes being in use, out of use and also of those being in an experimental phase (but already published) are discussed within the given restrictions, in addition to the most important technical data of the radiosondes and a list of the radiosondes used at present. / MA /

142. Parker, M. J., 1961: LOKI-HASP rocket-sonde meteorological equipment. In Initiation of the meteorological rocket network, Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised, p. 135. / R /

43. Parker, M. J., 1961: Status of the HASP Navy meteorological rockets. In Conference on the Status of Meteorological Rocketry, December 5-6, 1961, El Paso, Texas, Conference Program. [R]

44. Parker, M. J., 1964: HASP, instrumented, release to prototype production for evaluation of the heads, 1.625-inch, rocket, MK 1 Mod O and MK 2 Mod O. Naval Ordance Lab., NOLTR-63-272, 69 p. AD-433567.

The development history is presented of the instrumented High Altitude Sounding Projectile (HASP) that senses atmospheric temperature and winds to 150,000-feet altitude. The following are discussed in particular, flight-test program, electronic circuitry, environmental-test program, and performance of radiosonde set WOX-1A. [STAR]

45. Parker, M. J. and others, 1962: Report on phase II of the feasibility committee for 200,000-foot altitude instrumented HASP. Naval Ordnance Lab., NOLTR 61-15, 1 v.

46. Pinkston, J. K., 1961: Characteristics of vertical probe rocket vehicles. Air Proving Ground Center, Air Force Systems Command, APGC-TR-61-43. AD 267 429. [R]

47. Pobiiakho, V. A., 1961: Radiozond RKZ-1A [Radiosonde RKZ-1A]. Meteorologiia i Gidrologiia, 11, 50-53.

A description of the construction, operation and underlying principles of the RKZ-1A radiosonde which consists of automatic units of pressure temperature and humidity and a radio transmitter. The reports of the values of the meteorological elements of the free atmosphere are transmitted as coded radio signals which are used also by radar stations for orienting and automatically guiding the radiosonde according to angular coordinates. The pressure element consists of an aneroid box, a transmitting mechanism, an arrow, a contact scale and a double switch. The temperature sensor consists of a transistor element representing a capacity semiconductor resistance with a large dependence of the resistance upon temperature variation. The moisture unit is a living membrane which responds to moisture more readily

than hair. The radio unit consists of three interconnected parts: a measuring generator, modulator, and transmitter. The properties of each of the units of the sensors and radio apparatus, the characteristics of the tape record and the computation of the weather elements are described. /MA/

148. Pocs, Konstantins, 1964: A preliminary evaluation of the Cricketsonde rocket system. Air Force Cambridge Research Laboratories, AFCRL-64-469, 14 p.

Test flights of the Cricketsonde rocket were conducted by AFCRL to determine the operational feasibility of this low level meteorological rocket system. Designed as an inexpensive reliable and safe method for obtaining meteorological data up to 3,000 ft altitude; the Cricket employs a cold-type propellant and a 403 mc radiosonde telemetry package which is ejected at apogee and descends by parachute. Flight results indicate that the Cricketsonde has a good potential as an operational system. Problem areas relating to its optimum use are explored.

149. Poppoff, I. G., G. B. Bell, and I. S. Yaffe, 1957: A low-cost meteorological rocketsonde system, phase 1 - feasibility study. Final Report, Stanford Research Institute, Project SU-1610-4. (See also: Poppoff, I. G., Astronautics, Sept., 1958, p. 26.) /R/

150. Rados, Robert M., 1960: The U-2 as an instrumented aircraft for geophysical research. Weatherwise, 13 (6), 233-236; 268-269.

The availability of the U-2 aircraft has considerably advanced the work of geophysical research; various new instruments have been developed as a result. Due to the limited space available in U-2, the instrumentation is being divided into several parts, each specializing in a certain area of research. A diagram gives a thorough explanation of the instrument system. Two new types of spectrometers are being used to study the infrared transmission of the atmosphere at altitudes of 40,000 ft or more. The study of interplanetary matter is being conducted by the collection of dust particles in the stratosphere. /MA/

51. Rapp, R. R., 1952: The effect of variability and instrumental error on measurements in the free atmosphere. New York Univ., Meteorological Papers Volume 2, No. 1. [R]

52. Reber, Carl M., 1962: The airplane as a meteorological instrument platform. U. S. Weather Bureau, National Hurricane Res. Project Report No. 50, Part 1, 149-155.

Traces the development from Pickard's balloon ascents through the Thunderstorm Project to the present and states that today the airplane is still the most versatile upper air data collection vehicle. The requirements to be met by the ideal airplane for meteorological research are listed and the author concludes that it is highly unlikely that we shall see this ideal vehicle in the future because of the tremendous cost of aircraft development. High reliability, long range capability, economy of operation, and versatility were the minimum requirements considered in selecting the current Weather Bureau research aircraft, 2 Douglas DC-6A's and a Martin B-57A. More recently, a Douglas B26C was added to the fleet to provide an economical airplane for special tasks. The fundamental requirements for the instrumentation are listed. Today, data recording systems continuously receive inputs from the sensors, code the information into binary computers, sequence it, and then place the data on magnetic tape at a rate of up to 10 complete data samples (each data sample being 150 characters)/sec. The tape format is directly acceptable to the ground computer, an IBM 650. A block diagram of the digital data handling system is shown. The accuracy of coding and the resolution of encoders are discussed. The resolution afforded some of the parameters is listed in a table. The placement of probes on an airplane, so as not to allow the airplane to affect adversely the environment, is discussed and a curve of temperature correction for dynamic heating is shown. It is concluded that the systems described here are helping to identify meso- and microscale features of the atmosphere that previously in many cases, were more in the realm of speculation.

53. Roberts, W. C., Jr., R. C. Webster, and W. D. Charles, 1961: ARCAS and Metroc sounding rockets - a status report. Atlantic Research Corporation. [R]

154. Rofe, Bryan, 1963: Accuracy of meteorological measurements at Woomera, 1963. Weapons Research Establishment (Australia), SAD-125, 22 p.

Meteorological measurements are required for the analysis of missile trials and for the definition of models of the atmopshere. The accuracy of meteorological measurements at Woomera of the basic atmospheric parameters is discussed. /STAR/

155. Rofe, Bryan, 1963: Australian sounding rocket experiments, Salisbury, South Australia, 1963. Weapons Research Establishment (Australia), SAD-127, 18 p.

156. Ruskin, R. E., Research use of instrumented drones in cloud physics and meteorology. Naval Research Laboratory, Report 5923, 14 p. AD 408 742.

Small drone aircraft have been evaluated by other investigators in the past for several cloud physics and meteorological research applications which are not practically solved by other means. During April and May 1962, nine flights were made in a field evaluation of the suitability of a 13-ft-wingspan standard target drone aircraft as an instrument platform for cloud physics and meteorological research. These drones, while sufficiently small to create minimum disturbance to small clouds, are designed to operate above 40,000 ft in altitude and in higher turbulence than small manned aircraft can tolerate. The evaluation indicates that this type of drone can readily be modified to incorporate 75 lb of interchangeable meteorological and cloud physics instrumentation and to telemeter to a ground receiver or mother aircraft. In future planning of large cloud physics research projects, use of drones can add to manned aircraft capabilities if the proper safety factors can be provided, particularly a flight-restricted air space.

157. Ruskin, R. E., B. G. Julian, and J. M. Averitt, 1958: An aerograph for temperature soundings from aircraft, Final Report on Aerograph AN/AMQ-8 development. National Research Lab., NRL Report 5166. /R/

58. Schwidkowski, Eugen, 1961: Messungen mit Hilfe von Raketen (Raketen-aerologie) /Measurements with rockets (rocket aerology)/. In Handbuch der Aerologie, Walter Hesse, ed., 531-586.

A review of the following types of meteorological rocket sounding systems used in the last decade: the objectives, history and development, types Aerobee-Hi (U.S. Navy); Soviet meteorological rocket; Rocoon (firm balloon); theoretical basis (meteorological parameters, variations from normal, sound velocity, gas equations, drag shock-waves, kinetic effects, hydrostatic equations, heat exchange, sound propagation in atmosphere, ballistic movements); temperature measurements with thermometers in high atmosphere; manometer and other pressure and temperature measurements in low stratosphere, nose cone effects, measurements above 100 km; acoustical soundings of temperature and wind; falling sphere measurement of temperature and density; atmospheric composition measurements with mass spectrometers, ionization, ozone and other meteorological measurements with rockets (electron density, micrometeorites, solar radiation, geomagnetic and electric field measurements, etc.) Examples of soundings are given and construction and instrumentation of rocket types shown graphically. /MA/

9. Sharenow, Moses, 1958: High-altitude nighttime balloons. Bull. Am. Met. Soc., 39 (12), 648 651.

An experimental high-altitude balloon suitable for nighttime use was recently developed and tested in both tropic and temperate latitudes. Results of tests indicate the balloon is capable of attaining a bursting altitude in excess of 100,000 ft with slightly more hydrogen than that required by existing night balloons now used to attain an altitude of 80,000 ft. Some reduction in the size of the balloon will be required to make it suitable for inflation in existing shelters.

J. Sharenow, Moses, 1961: Streamline neoprene balloons. Bull. Am. Met. Soc., 42 (5), 334-344. /R/

1. Siderman, Joseph A., 1962: Integrated artillery ballistic meteorological system study and design. Army Electronics Research and Development Lab., ASRDL TR-2280, 78 p. AD-295 173.

Requirements of the Military Characteristics for an Integrated Artillery Ballistic Meteorological System (IABMS) and the proposed techniques that are to be employed for meeting them are discussed. The study and design criteria for an effective, reliable, and automated atmospheric sounding system for use by a highly mobile, quick-reaction army of the 1970-1975 time frame are discussed and described. This system, the Artillery Ballistic Meteorological System (ABMS), would have a capability of automatic data handling and conversion and processing of the sounding data. A number of ABMS units distributed throughout an army area, together with an effective communication system and a meteorological data central with computational facilities, comprise an IABMS, and can provide the U. S. Army with a capability of integrated and/or autonomous operation. The IABMS will be compatible with the proposed Army Integrated Meteorological System (AIMS).

162. Slater, R., 1959: A constant-level, sealed, super-pressure balloon. In Conference on Stratospheric Meteorology, Minneapolis, Aug. 31-Sept. 3, 1959, Papers of the Conference, 9 p.

This paper describes the progress in closed cell, plastic, super-pressure balloon development and the flight characteristics of this system with respect to constant level, long duration flights and their possible use as a radiation sensor. The application of the system to trajectory soundings is also discussed. /MA/

163. Smith, L. B., 1961: The meteorological rocket program at Tonopah Test Range. In Conference on Status of Meteorological Rocketry, Dec. 5-6, 1961, El Paso, Texas. /R/

164. Smithson, G., 1956: Modification, design and development of balloon flight equipment. Lowell Technological Institute Research Foundation, AFCRC TR-57-259. AD 117 149. /R/

165. Spalding, T. B., and S. B. Solot, 1961: Horizontal sounding balloon feasibility study. Air Force Cambridge Research Labs., GRD Research Notes No. 56.

This Note discusses a study to determine the feasibility of using plastic balloons that float freely at constant density altitude to

provide a more comprehensive understanding of the atmospheric circulation in the Northern Hemisphere. The study indicates that development of an effective and economical means of gathering weather data over the Northern Hemisphere using such balloons is feasible. One area that required considerable research and development is the concept of two dimensional and distributed electronics. There are other areas in the total program that also require development, such as, the balloon vehicle itself, a tracking network, and associated balloon distribution network. Nevertheless, it appears that all of these areas can be successfully developed prior to the development of two dimensional balloon electronics. The first step toward the future use of this technique will require considerable funding for development of minimal mass electronics, the balloon vehicle, balloon instrumentation, tracking, and statistical analysis of balloon flight trajectories.

166. Sparton Corporation, 1963: Final engineering report for the environmental meteorological data system. Sparton Corporation, MTC-TDR-63-8, 41 p. AF 08(606)-5719, AD 427991.

The object of the work performed under Contract AF 08(606)-5719 was to develop a radiosonde compatible with the operational electromagnetic environment of the Atlantic Missile Range. The presence of high-level radiation on adjacent frequencies make the standard AN/AMQ-9 unreliable in such an environment. Design objectives were (1) improved selectivity, (2) tuned frequency stability, (3) improved dynamic range, (4) reduced susceptibility to spurious responses and (5) provide five (5) channels with provisions for selection of [illegible] by changing one (1) component

167. Spencer, Paul R., 1961: Study of a solar sensor for use in space-vehicle orientation control systems. National Aeronautics and Space Administration, NASA TN D-885, 39 p.

A solar sensor is proposed to meet the existing need for orienting space vehicles toward the sun. Consideration has been given to such requirements as reliability, capture capability, sensitivity, and power consumption. The effects of varying certain design parameters are shown and improvements are suggested. The effects of a space environment are discussed. Results obtained from an experimental model of a solar sensor are presented. [MA]

168. Sweeney, M. W., Jr., 1955: Supersonic wind-tunnel measurements of surface pressures on a small rocket to be used for upper-air research. Massachusetts Institute of Technology, Wind Tunnel Report 80. AF 19(604)-1208, AD 82 438. /R/

169. Todd, William, and Arthur Coppola, 1959: A low cost rocket parachute rocketsonde. In Conference on Stratospheric Meteorology, Minneapolis, Aug. 31-Sept. 3, 1959, Papers of the Conference, 1 p.

A low cost rocket parachute radiosonde has been developed to measure atmospheric parameters up to 200,000 ft. The instrumentation known as radiosonde set AN/DMQ-6, is a rocket adaption of the new balloon-borne radiosonde AN/AMQ-9 and is used with rawin set AN/GMD-2. This latter equipment permits determination of wind through tracking in angle and range and additionally provides reception of the telemetered data. The rocket instrument is intended for application to relatively low acceleration solid fuel rockets such as the ARCAS. The four channel sequential telemetering is designed so that a considerable latitude in sensor type is possible. /MA/

170. Wagner, N. K., 1961: The effect of the time constant of radiosonde sensors on the measurement of temperature and humidity discontinuities in the atmosphere. Bull. Am. Met. Soc., 42 (5), 317-321. /R/

171. Waters, M. H. L., and A. C. Browning, 1961: The use of parachutes at high speed and high altitude. Royal Aircraft Establishment, Ministry of Aviation, London, Tech. Note Mech. Eng. 340. AD 267 692. /R/

172. Watson, Clarence W., 1964: JUDI-ROBIN balloon DART sounding vehicle. Final Report, Rocket Power, Inc., AFCRL-64-471, 72 p. AF 19(628)-2805, AD-607074.

The system has been designed to provide a low cost, passive meteorological system to obtain atmospheric density and wind data at altitudes from 100,000 to 215,000 feet. The sensor is a super-pressurized mylar balloon, which is one meter in diameter and contains a corner reflector. The balloon is tracked by radar, and the desired information is obtained from the position-time history. Sixteen balloons were ejected from the DART in a vacuum chamber, and 15 flight tests were conducted. Two additional flights were conducted with telemetry aboard to measure the internal temperatures of the DART. The program demonstrated that the balloon could be ejected reliably at the desired altitude. Some difficulties were experienced with the balloon inflation on the first three flights. However, an additional coat of insulating material solved this problem on subsequent flights. The standard ROBIN balloon system was used. /STAR/

173. Wenzel, R. F., 1964: Air-launched rocketsonde study. General Dynamics Corp. AFCRL-64-59, 434 p. AF 19(628)-3265, AD-601 216.

A study was conducted on the feasibility of incorporating an air-launched rocketsonde into the existing WB-47 AN/AMQ-19 meteorological system. An economically feasible system was established, one capable of carrying pressure, temperature and humidity sensors. Sensors to 150,000 ft growth capability in the design permits attainment of 400,000 ft altitudes with the same Judi (or Loki II) rocket motor.

174. West, D. C., 1960: Flight test evaluation of the AN/AMT-6 radiosonde system. WADC TR 59-729. AD 241 451. /R/

175. Widger, William K., Jr., 1963: Meteorological satellites and weather reconnaissance aircraft - complementary observing systems. Bull. Am. Met. Soc., 44 (9), 549-563.

The development of aircraft weather reconnaissance techniques provided a method of obtaining meteorological data, especially from remote or data sparse regions, with a density of observations that would not be practicable using surface-based procedures. Similar capabilities have recently become available from a second type of platform - the meteorological satellite. Nevertheless, the advent of the meteorological satellite does not foreshadow the obsolescence of the weather reconnaissance aircraft. Rather, both the satellite and the aircraft have their own strengths and limitations; together, they provide a complementary capability for obtaining data of significance for both operational and research purposes.

176. Zabrodskii, G. M., V. A. Zaitsev, A. A. Ledokhovich et al., 1960: Opyt zondirovaniia atmosfery na samolete TU-104 /Atmospheric sounding

by TU-104 airplane /. Glavnaia Geofizicheskaia Observatoriia, Trudy, No. 104, 53-67.

The authors describe the construction and operation of meteorological instruments which can be installed on TU-104 aircraft for investigating the atmospheric temperature and its pulsations, atmospheric humidity and transparency of clouds. These instruments are an airplane screened thermometer with a meter of temperature pulsation, an aircraft thermohygrometer for visual reading of the atmospheric temperature and dew point, a photoelectric device which determines the attenuation of light rays emitted by the instrument itself for measuring the optical density of clouds. A diagram of the stand of the screened thermometer, a circuit diagram of the screened thermometer with the temperature pulsation meter and the optical scheme of the transparency meter are presented. The results of measurements of the temperature field within thick cumulus clouds and in their immediate vicinity, and examples characterizing the variability of temperature, transparency, potential gradient of the electrical field and lift of an aircraft in thick cumulus and cirrus clouds are given in graphs. The mean temperature in a thick cumulus cloud and in the adjacent layer is higher than in the surrounding cloud free air. Turbulent pulsations of temperature and of virtual velocities within clouds differ both in frequency and amplitude from similar pulsations in cloud free air. The fluctuations of transparency of clouds to visible parts of the spectrum are in close agreement with the potential gradient of the electrical field within the clouds. The variability of these physical properties of clouds reflects the variability of the spectrum of cloud particles and water content. / MA /

177. Zaichikov, P. F., and V. D. Litvinova, 1958: Zavisimost' vysoty pod"ema sviazok radiozondovykh obolochek ot temperatury i atmosfernoi turbulentnosti / Dependence of the ascension height of radiosonde balloon clusters upon temperature and atmospheric turbulence /. Tsentral'naia Aerologicheskaia Observatoriia, Trudy, No. 24, 48-51.

In order to raise scientific instruments weighing from 70 to 100 kg to a height of 25 to 30 km, a cluster of 150 balloons is generally used. Data of vertical velocity measurements obtained by vertical anemographs have established that: 1) vertical movements are in the form of waves that differ in periods and amplitude; 2) the most common are waves of small periods and small amplitude; 3) amplitudes increase with periods and 4) when there is drift, waves of various periods are observed. A table showing heights attained by radiosondes at various dates and minimum temperatures recorded is included. Graphical representation of changes in the angle of inclination of wind vectors and heights attained by radiosondes are included. It is concluded that the ascension height of radiosonde balloon clusters depends upon the temperature and the amount of change in the angle of inclination of the wind vectors. /MA/

TEMPERATURE SENSORS

See also: Air Force Proving Ground Command, 1956: Employment and suitability test of the AN/AMT-6 parachute radiosonde system . (65)

Army Electronics Research and Development Activity, 1962: Performance characteristics of meteorological rocket wind and temperature sensors. (256)

Attmannspacher, W., J. Borstinger, and J. Wiehler, 1964: Preliminary results on rocketsonde measurements of wind and temperature in the upper stratosphere and in the mesosphere at Capo San Lorenzo during October/November 1963. (258)

Bendix Corporation, 1962: Cricketsonde meteorological rocket and instrument package. (81)

Cambridge Systems, Inc., 1964: Temperature/dew point set Model 110S. (369)

Cato, G. A., 1964: Ultra-high altitude measurement systems for pressure, density, temperature, and winds. (585)

Champion, K. S. W., and A. C. Faire, 1964: Falling sphere measurements of atmospheric density, temperature, and pressure, up to 115 km. (587)

Coppola, A. A., 1963: Radiosonde set AN/DMQ-6. (90)

Jones, L. M., F. F. Fischbach, and J. W. Peterson, 1962: Atmospheric measurements from satellite observations of stellar refraction. (561)

Maeda, K., Y. Takeya, H. Matsumoto, et al., 1961: Atmospheric temperature and wind measured by the Kappa rocket. (306)

Masterson, J. E., W. E. Hubert, and T. R. Carr, 1961: Wind and temperature data measured by meteorological rockets at Point Mugu, California. (310)

Nagy, A. F., N. W. Spencer, H. B. Niemann, and G. R. Carignan, 1961: Measurements of atmospheric pressure, temperature, and density at very high altitudes. (565)

Pearson, P. H. O., 1963: Measurement of atmospheric density, temperature, and pressure at Woomera on 29th March 1962 by the falling sphere method. (607)

Pinkau, K., and H. Selk, 1963: Radiosonde for exact measurement of air pressure and various temperature values. (568)

Schotland, R. M., et al., 1962: Optical Sounding. (435)

Schotland, R. M., et al., 1963: Optical Sounding. (436)

Thiele, O. W., 1963: Mesospheric density variability based on recent meteorological rocket measurements. (616)

Thiele, O. W., 1964: Some observed short term and diurnal variations of stratospheric density above 30 km. (618)

Wenzel, R. F., 1964: Air-launched rocketsonde study. (173)

Whipple, F.L., 1960: Meteors in the measurement of the upper atmosphere. (622)

178. Badgley, F. I., 1957: Response of radiosonde thermistors. Rev. Sci. Instr., 28, 1079-1084. /R/

179. Ballard, H. N., 1961: Response time of and effects of radiation on the Veco bead thermistor. Texas Western College, Schellenger Research Laboratories, April 7, 1961. Also: Supplement No. 1, August, 1961. /R/

180. Ballard, H. N., 1961: Response time of and effects of radiation on the VECO bead thermistor. Instrument Society of America Fall Instrument-Automation Conference and Exhibit, Los Angeles, California, September 11-15, 1961, Preprint 167-LA-61. /R/

181. Bandeen, W. R., 1959: The recording of acoustic waves from high-altitude explosions in the rocket-grenade experiment and certain other related topics. U. S. Army Signal Research and Development Laboratory, USASRDL TR-2056. /R/

182. Bandeen, W. R., and J. Otterman, 1960: Temperature correction in the rocket-grenade experiment due to the finite-amplitude-propagation effect. J. Geophys. Res., 65 (3), 851-855. [R]

183. Barnes, Thomas G., and Carlos McDonald, eds., 1962: Determination of atmospheric parameters by acoustic means. Progress Report No. 1, Texas Western College, Schellenger Research Laboratories, 242 p.

This progress report is a summary of research and development on an acoustic technique for measuring upper air temperatures and density from a moving platform. The report includes a literature survey; theoretical and laboratory investigations of problems inherent in performing acoustic measurements in the upper atmosphere by devices on moving platforms; and the theory, design, development, and laboratory testing of an air-borne acoustic interferometer for performing local acoustic measurements in the upper atmosphere. It is concluded on the basis of the theoretical arguments and laboratory tests that the local speed of sound could be determined by the proposed device, at altitudes up to about 45 km, from which the temperature can be derived.

184. Barr, W. C., 1961: Theoretical considerations in the design of atmospheric temperature-sensing elements. U. S. Army Signal Research and Development Laboratory, USASRDL TR-2195. [R]

185. Barrett, E. W., and V. E. Suomi, 1949: Preliminary report on temperature measurement by sonic means. J. Met., 6, 273-276. [R]

186. Berdan, M., 1960: Field operation of rocket grenade atmospheric sounding system. U. S. Army Signal Research and Development Laboratory, USASRDL TR-2096. [R]

187. Blamont, Jacques-Emile, and Marie-Lise Lory, 1963: Mesure de la température de l'atmosphère de 100 à 200 km au moyen de nuages de potassium créés par fusées [Temperature measurements in the atmosphere from 100 to 200 km by means of potassium clouds emitted by rockets]. Académie des Sciences, Paris, Comptes Rendus, 257, 1135-1138.

In a former statement, Blamont showed that it is possible to measure the temperature of the atmosphere by determining the width of the resonance line of Na light emitted by twilight by an artificial cloud above 100 km. This paper deals with the first results obtained with K which made it possible to establish a model of temperature variation with altitude at twilight. The instruments used to investigate the luminous intensities emitted by the artificial cloud are described. The first K clouds were emitted in May and June 1960 by means of Veronique rockets. The first temperature measurements, however, were made by means of Centature rockets launched in Dec. 1961. The measurements reported in this paper resulted from the firings made on June 5, 1962 at Hammaguir (in the morning and in the evening). A figure represents the experimental model of the atmospheric temperature between 100 and 200 km at the morning and evening twilight for the years 1960-1962. / MA /

188. Brasefield, C. J., 1948: Measurement of air temperature in the presence of solar radiation. J. Met., 5, 147-151. / R /

189. Cambridge Systems, Inc., 1961: Prototype sonic temperature transducer for balloon and rocket use. / R /

190. Cary, A. F., 1949: Final Report on an experimental evaluation of the infrared method of measuring free air temperature at supersonic speeds. The Franklin Institute, Final Report F-2015-4-1. / R /

191. Combs, Andrew C., 1963: Meteorological applications of infrared radiometry. U.S. Army Signal Research and Development Laboratory, USAELRDL-TR-2373, 25 p. AD-425911.

Portable Infrared Radiation Thermometer model 14-310, provides more accurate surface temperature measurements and cloud temperature measurements ($\pm 1^{\circ}C$) than the R-4D1 industrial Radiometer. The use of a standard radiation source, such as melting crushed ice, while in flight makes it possible to correct for any effects of ambient temperature on the 14-310 sensing head and amplifier. Results obtained using the R-4D1 radiometer provide a basis for pursuing the development of a radiometer for free-air temperature measurement in the 15 μ (carbon dioxide) spectral region. / STAR /

192. Duchon, Claude E., 1963: Infrared radiation temperature correction for spherical temperature sensors. J. Appl. Met., 2, (2), 298-305.

Steady-state radiation temperature correction, defined as difference between observed sensor temperature and true air temperature, is computed for clear nighttime conditions in terms of sphere diameter, wind speed, observed sensor temperature, total incident radiation, and absorptivities and emissivity of sphere; infrared radiation incident on sphere in boundary layer of atmosphere is related mathematically to radiation observed by flat plate type of radiometer; correction to be added to observed sensor temperature varies from less than 0.01 K to 3 K. /EI/

193. Duchon, Claude E., 1964: Estimates of the infrared radiation temperature correction for cylindrical temperature sensors. J. Appl. Met., 3 (3), 327-335.

A series of nomograms is presented showing the longwave radiation temperature correction for various thermocouple wire diameters, different values of emitted and absorbed radiation, and for wind speeds from zero to 10 m sec^{-1}. The temperature correction is computed from the steady-state balance between radiative and convective heat transfers and is to be added to the measured temperature. The radiation field is based upon [illegible] measurements made under clear nighttime skies [illegible] and forced convection correlation formulae are adopted from wind tunnel experiments.

194. Ference, M., W. G. Stroud, J. R. Walsh, and A. G. Weisner, 1956: Measurement of temperatures at elevations of 30 to 80 kilometers by the rocket-grenade experiment. J. Met., 13 (1), 5-12. /R/

195. Finger, F. G., R. B. Mason, and S. Teweles, 1964: Diurnal variation in stratospheric temperatures and heights reported by the U. S. Weather Bureau outrigger radiosonde. Mon. Wea. Rev., 92 (5), 243-250.

The diurnal change in temperature and height measured by the new U.S. Weather Bureau outrigger radiosonde at and above 100 mb has been determined from pairs of successive radiosonde observations taking place in daylight and darkness. Analyzed graphs of the change

as a function of solar elevation angle are presented. For a given solar angle, the observed diurnal variations are found to be larger with afternoon daylight than with morning daylight. Furthermore, values computed for Plateau stations with afternoon daylight are particularly large.

Use of the white 50-mil rod thermistor with outrigger mounting has radically improved the compatibility of reported temperatures and heights at adjacent stations, primarily because the radiational temperature error has been reduced by a factor of about two to four. The observed diurnal variations measured by this new instrument are comparable with those of the military outrigger radiosonde, allowing for the slightly smaller thermistor of the latter.

196. Frisch, Alfred, and Hans Gerhard Müller, 1960: Der albedobedingte Strahlungsferhler der Radiosonde H 50 [Radiation error of the H-50 radiosonde due to albedo]. Meteorologische Rundschau, 13 (5), 140-147.

Experience shows that it is not possible to find a good correction for the influence of solar radiation on bimetallic temperature elements of radiosondes, unless considering the effect of light reflected from the earth and cloud surfaces. The effect has proved to be as important as the sun's altitude. Comparisons are made between height differences of standard pressure levels using night and daytime radiosonde runs assorting for different altitudes of the sun and several amounts of cloud cover. A correction formula for different pressure levels is given. Another method of computing solar radiation errors by comparison of ascent and descent temperature values is discussed. Corrections originating from this method are shown to be in good agreement with those from the previously mentioned.

197. Fryberger, D., 1963: Measurement of atmospheric temperature by radiometer. In The Appl. of Passive Microwave Technol. to Satellite Meteorology: A Symposium. Armour Research Foundation, NASA.CR-52130, 50-56. NASr-21(07).

An inversion technique is discussed which premits the deduction of a temperature profile from interpreted readings. The power received by the radiometer, in this case, can be related to an integrated temperature by the Nyquist noise relationship. [STAR]

198. Fryberger, D., and E. F. Uretz, 1961: Some considerations concerning the measurement of the atmospheric temperature field by electromagnetic means. IRE Trans. on Military Electronics, MIL-5, 279-285. / R /

199. George, J. L., and W. H. Peake, 1960: Survey of the literature on temperature determination at altitudes above 120,000 feet. The Ohio State University Research Foundation, 973-1. DA-36-039-SC-84516, AD 235 897. / R /

200. Gershenzon, G. S., and K. N. Manuylov, 1963: On the rate of detecting temperature gradient changes by measuring instruments. Air Force Systems Command, Foreign Technology Div., FTD-TT63-540, 4 p. AD-415 007.

This report is devoted to the problem of explaining the ability of the instrument to react to changes in rate of heating or cooling and object of measurement, i. e. in case of change in vertical temperature gradient during vertical sounding of the atmosphere.

201. Glagolev, Yu. A., 1960: Vozmozhnosti izmereniia temperatury svobodnoi atmosfery s pomoshch'iu tonkogo termometra soprotivleniia na sharakh do vysot 30-35 km / Possibilities of measuring temperature in the free atmosphere by means of thin resistance thermometers carried by balloons up to altitudes of 30-35 km /. Tsentral'naia Aerologicheskaia Observatoriia, Trudy, No. 37, 62-74.

In this discussion of the possibility of using thin resistance thermometers on balloons to measure more accurately atmospheric temperature at altitudes up to 30-35 km, the author examines the influence upon the thermometer reading exerted by direct solar radiation and radiation reflected from clouds and from the housing of the thermometer during the elevation and rotation of the balloon. From the equation of state of the thermometer suspended in the balloon the equations for determining the true air temperature taking into account the radiation, heating by the frame of the thermometer and the thermal radiation of the housing. The results of computations are presented in tables. When rotation is used to intensify heat exchange the air temperature at 30 km may be obtained by day with a radiation error of $< 1.1^{\circ}C$ if the radiation correction is not applied; if it is applied the error is $<0.6^{\circ}C$. At lower altitudes the air temperature may be measured with high accuracy. When the rotating thin resistance thermometer is used and when precautions relative to the distorting effect of the housing are taken, the fluctuations of temperature during flight having a value of 0.05°C and more and 0.5°C and more at 30 km will reflect accurately the temperature fluctuations of the surrounding air when a 40 micron wire is used. /MA/

202. Glagolev, Yu. A., 1962: Measurement of temperature of the air by means of the rotating wire resistance thermometer. Bulletin (Izvestiva) Academy of Sciences, Geophysics Series, No. 1, English Edition, 92-95. /R/

203. Glagolev, Yu. A., 1964: Eksperimental'nye dannye o mikrostrukture temperaturnogo polya na vysotakh 20-30 km. Akademiya Nauk SSSR, Izvestiya, Seriya Geofizicheskaya n 6, 947-952.

Experimental data on microstructure of temperature field at altitudes of 20-30 km; analysis of experimental data recorded by means of rotating aerological thermometer during vertical sounding of atmosphere and during drifting on July 5, 22, and Oct. 27, 1960. /EI/

204. Glass, D. R., L. F. Ornella, R. J. Kelley, D. A. Dolley, and R. L. Gealer, 1957: Methods for measuring ambient-air temperatures from high speed aircraft. Wright Air Development Center, WADC TR 57-705. AD 142 169. /R/

205. Gol'tsman, M. I., and V. V. Frolov, 1960: Ob oshibkakh v izmereniiakh temperatury radiozondami /Errors in temperature measurements by radiosondes/. Problemy Arktiki i Antarktiki, No. 3, 53-63.

In connection with new methods of sounding of the atmosphere by means of radiosondes, airplanes, rockets, Earth satellites, etc., the accuracy and consistancy of the results were studied with the P. A. Malchanov method. This method was applied to 370 soundings conducted by 14 different countries during May-June 1956, at the average height of 22.1 km. Measurements of pressure, temperature and humidity were made at different atmospheric levels, during ascents and descents, by different apparatus. These measurements are discussed in detail and data tabulated. The pressures were measured by aneroids, hypsothermometers; temperatures by bimetallic plates of different sizes, thermocouples and by mercury thermometers (Japanese) and humidity, by hygrometric elements (hair, goldbeater's-skin and lithium chloride). Average differences in temperature readings of U.S.S.R. and different countries (U.S.A., France, England, Japan and Finland) are tabulated for different altitudes during day and night. Corrections for the effects of solar radiation with good heat insulation, or by computation with observed temperatures were considered. The effect of inertia on the thermometer (temperature lag) due to physical dimensions was also considered in correcting the observed readings. / MA /

206. Groves, G. V., 1956: Theory of the rocket-grenade method of determining upper atmospheric properties by sound propagation. J. Atmospheric and Terrest. Phys., 8, 189-203. / R /

207. Groves, G. V., 1956: Effect of experimental errors on determinations of wind velocity, speed of sound and atmospheric pressure in the rocket-grenade experiment. J. Atmospheric and Terrest. Phys., 9, 237-261. / R /

208. Gruber, A., 1962: Eine Modifikation der amerikanischen Radiosonde AMT-4 zur Behebung von Messfehlern durch Feuchtigkeitsbeschlag / A modification of the American radiosonde AMT-4 to eliminate errors due to condensation of moisture /. Archiv für Meteorologie, Geophysik und Bioklimatologie, Ser. A, 12 (4), 474-481.

It is shown that, by eliminating the relay and, therefore, the relay voltage from the commutator the state of the latter with respect to isolation (humidity, contamination) does no longer affect the temperature measuring circuit. In the modified radiosonde, the humidity element is connected in parallel to the temperature element. This results in an extension of the humidity measuring range down to about 15%. The temperature recording trace becomes the base-line for the humidity or other additional traces. / MA /

209. Gupta, J. P., and R. C. Maheshwari, 1962: Radiation and lag errors of the chronometric type radiosonde. Indian J. of Met. and Geophys., 13 (4), 516-520.

The radiation and lag errors of the temperature element of the C-type radiosonde were determined in the laboratory using a wind tunnel constructed for this purpose. The experimental arrangement and the results obtained are briefly discussed. /MA/

210. Halpern, C., 1963: Bibliography of temperature measurement July 1960 to December 1962. National Bureau of Standards, NBS Monograph 27, Supplement 1, 14 p.

About 700 references are presented, collected from scientific and technical journals and reports on investigations sponsored or conducted by various governmental agencies; English, German, and French journals, and translations in English of Russian journals are covered, as well as more commonly used abstract journals. /EI/

211. Hame, T. G., W. H. Peake, B. C. Potts, and J. Shaw, 1960: Preliminary analysis of methods for temperature determination at altitudes above 120,000 feet. The Ohio State Univ. Research Foundation, Report 973-2. DA-36-039-SC-84516, AD 242 206. /R/

212. Haragan, D. P., N. K. Wagner, and J. R. Gerhardt, 1961: Wind and temperature in the atmosphere between 30 and 80 km. Sixth Quarterly Technical Report, October 1, 1961 through December 31, 1961, Texas Univ. DA-23-072-ORD-1564. /R/

213. Haragan, D. R., and N. K. Wagner, 1963: Wind and temperature in the atmosphere between 30 and 80 km. Eleventh Quarterly Technical Report, 1 Jan. 1963-31 Mar. 1963, Texas Univ., 34 p. DA-23-072-ORD-1564.

The error in temperature as indicated by rocketsonde thermistors is analyzed in terms of the variables associated with variation in temperature of the thermistor. A differential equation is derived which includes the effects of forced convective heat transfer, radiative heat transfer, compressional heating, heat conduction along thermistor lead wires, and internal heating. Many quantities appearing in this equation can be expressed as a function of height alone, and the power dissipation can be expressed as a function of thermistor temperature. A discussion of the variables and the expressions for their variations with height and temperature are presented. Current problems in stratospheric meteorology are reviewed to evaluate those which can be investigated within the framework of the Meteorological Rocket Network. /STAR/

214. Harrison, D. N., 1961: Radiosonde temperature readings and cloud amount. The Met. Mag., 90, (1072), 319-325. /R/

215. Ingle, G. F., 1963: Using transistors for temperature measurement. Electronic Equipment Eng., 11 (8), 53-55.

Method of utilizing temperature-sensitive base-to-emitter voltage of transistor as temperature sensor; this transistor voltage varies linearly with temperature, and can be applied to voltage-controlled oscillator to obtain signal whose frequency varies linearly with temperature; for circuits shown, astable multivibrator frequency changes by about 1.5 kc over range of minus 70 C to plus 70 C; unit has been used to telemeter temperature data from high-altitude balloon. /EI/

216. Konozenko, D., and Zh. A. Zaika, 1963: Pribor dlya snyatiya teplovoi karty mestnosti tip SIT-2K, I. Akademiya Nauk SSSR, Izvestiya, Seriya Geofizicheskaya n 11, 1758-1761.

Apparatus of SIT-2K type for mapping of thermal conditions; apparatus recording infrared radiation designed to register temperature above 8 C at altitude up to 1 km and to discriminate areas where temperature difference is 1.5-2 C. /EI/

217. Miers, B. T., and N. J. Beyers, 1964: Rocketsonde wind and temperature measurements between 30 and 70 km for selected stations. J. Appl. Met., 3 (1), 16-26.

Rocketsonde wind and temperature measurements from most of the National Meteorological Rocket Network (or simply Rocket Network) stations are studied. In the altitude region considered, there were over 1100 wind measurements and some 200 temperature soundings. This includes Rocket Network data through August 1962 and a few 1957 and 1958 soundings taken prior to the initiation of the Rocket

Network. A simple statistical treatment has been used to determine mean temperatures and mean wind speeds, components, shears, and a measure of variability. The wind data presented generally support previously constructed cross sections of the wind regime over North America. A significant mass transport from subtropical to mid-latitudes was indicated. The meridional component of the subtropical wind did not reverse direction with the seasonal change in the zonal wind. In the subpolar stratosphere the seasonal changes of temperature are much more pronounced: the summer is warm (near subtropical values) and the winter much colder. The subtropical summer temperatures were found to be colder than the subtropical winter temperatures. There is still a significant disagreement as to the more refined temperature structure of the subtropical region.

218. Mordukhovich, M. I., 1959: Lokal'nyi akusticheskii metod izmereniia temperatury vozdukha /Local acoustical method of measuring air temperatures/. Akademiia Nauk SSSR, Izvestiia Ser. Geofiz., No. 3, 480-488. Also: English Edition of Bulletin (Izvestiia), Academy of Sciences, USSR, Geophysics Series, No. 3, 329-335. /R/

219. Ney, E. P., R. W. Maas, and W. F. Huch, 1961: The measurement of atmospheric temperature. J. Met., 18 (1), 60-80. /R/

220. Nordberg, W., 1962: Acoustic phenomena observed on rocket-borne high altitude explosions. National Aeronautics and Space Administration, NASA TN D-1294, 13 p. /R/

221. Nordberg, W., and W. Smith, 1963: A manual describing the rocket-grenade experiment. Goodard Space Flight Center, GSFC Document X-651-63-18.

This document describes the operation and performance of the rocket-grenade experiment. It is intended to serve as a reference manual, reviewing the experiment techniques for the benefit of persons wishing to apply this experiment to their own needs. The purpose of the rocket-grenade experiment is to measure wind velocities and temperatures, and to derive densities and pressures, by detonating explosive charges (grenades) at predetermined height intervals during the ascent of the rocket to altitudes of approximately 90 km.

222. Nordberg, W., and W. Smith., 1964: The rocket-grenade experiment. National Aeronautics and Space Administration, NASA TN D-2107, 32 p.

This manual describes the grenade technique which is employed to measure average ambient temperature and winds in horizontal layers between two successive grenade explosions. The technique is effective up to altitudes of 90 km. The method for deriving pressures and densities from the temperature information is discussed in detail. And finally, rocket-borne and ground-based instrumentation is delineated.

223. Peake, W. H., T. G. Hame, and B. C. Potts, 1960: Final Engineering Report July 1, 1959 to August 31, 1960 on temperature measurements at altitudes above 120,000 ft. The Ohio State Univ. Research Foundation, Report 973-3. DA-36-039-SC-84516, AD 252 143. [R]

224. Petit, M., 1956: Emploi de thermometres bilames blancs sans pare-soleil sur la radiosonde francaise [Use of white thermocouples without radiation shields on the French radiosondes]. J. Scientifique de la Meteorologie, Paris, 8, 47-53. [R]

225. Petit, M., 1959: Notes sur les thermometres a fil vibrant pour sondages stratospheriques [Notes on the vibrating thread thermometers for stratospheric soundings]. J. de Mecanique et de Physique de Atmosphere, Ser. 2, 179-190.

Vibrating thread thermometers could solve the problem of the measurement of air temperature at high altitudes. In the 1st part of this article, the author recalls the characteristics of the vibrating thread thermometer and the relations which bind the vibration frequency to the temperature. The 2nd part deals with the radioconvective balance and the author indicates the manner in which the dissipation coefficients of the thermometric threads employed were determined. It deals successively with the measurement of the calorific dissipation and with the heating due to the radiation. The radiation balance and the radioconvective balance are studied in the 3rd part. It seems that the radioconvective error may be less than 1°, up to about 40 km in altitude. [MA]

226. Petit, M., and A. Pepita, 1958: Un thermometre a corde vibrante pour la measure de la temperature de l'air dans la stratosphere / A thermometer with vibrating strings for temperature measurements in the stratosphere /. J. Scientifique de la Meteorologie, Paris, 10, 41-46. / R /

227. Quiroz, R. S., J. K. Lambert, and J. A. Dutton, 1963: Upper-stratosphere density and temperature variability determined from meteorological rocket network results, 1960-1962. U. S. Air Force, Air Weather Service, AWS-TR-175, 44 p. AD 431 703.

This report includes estimates of data accuracy.

228. Rachele, H., 1961: Sound propagation through a windy atmosphere. U.S. Army Signal Missile Support Agency, White Sands Missile Range, TR-109. AD 266 240. / R /

229. Rosemount Engineering Company: Model 103, Total temperature probe. Bulletin 15811. / R /

230. Rudomanski, A. C., 1962: Free air thermometer evaluation and pre-production. Final engineering report on Infra-red and Electro-Optics. Barnes Engineering Co., Report 4234, 34 p. NOa (s) 59-6114-c, AD-282 739.

The feasibility was studied of measuring free air temperature radiometrically from supersonic aircraft. The investigation, which included the construction and testing of a breadboard model, uncovered many problem areas which included the collecting optics, the detector spectral selectivity, and temperature control of the reference source. A 15 micron sensitive free air thermometer was subjected to ground testing to establish techniques needed for the design of a model radiometer for supersonic flight.

231. Schotland, R. M., and Eugene Chermack, 1961: Sounding of the atmosphere by indirect means, Pt. 5. Final Report, New York Univ. College of Engineering Div., Dept. of Meteorology and Oceanography, 45 p. Cwb-9987.

In this final report the subject is treated under the following main headings: I - A sounding technique based upon the interaction between sonic and electromagnetic traveling waves; II - The effect of large particles on back scattered radiation in the pulsed light system; and III - A determination of the temperature profile of the atmosphere by means of the Doppler shift in scattered light. Pt. I contains chapters on microwave application. In Pt. II five cases of scattering relations and the model atmosphere are discussed and computation procedures and results and conclusions are presented. Illustrations in this part include distributions of molecular number density with altitude, Aitken's particles with altitude, large particles with altitude, absorption as a function of wave length and precipitable water, and curves of transfer functions $\lambda = 0.31$, 0.33, 0.35, 0.85, 0.94 (RH = 0%), 0.95 (RH = 100%) and 1.0μ. A graph showing the effect of truncation on $\lambda = 0.31\mu$ is also presented. Pt. III contains a chapter on derivation of the energy density equation, conclusions, and a paragraph on future work. Illustrations include graphs of one dimensional velocity distribution (nitrogen 0°C) and of relative frequency spread due to Doppler broadening of scattered radiation by nitrogen at 0°C. Tables of size distribution of the Aitken particles and of large particles as a function of altitude, and a list of existing tables of K_s and/or i_1, i_2 applicable to meteorological scattering problems are appended to the report. /MA/

232. Schotland, R. M. and A. M. Nathan, 1963: The use of lasers for the remote determination of atmospheric temperature. In Second Symposium on Remote Sensing of Environment: Proceedings, 15-17 October 1962. Michigan Univ. Institute of Science and Technology, Infrared Laboratory, Report 4864-3-X, 415-426. NOnr 1224(44).

A method is proposed in which the temperature of the atmosphere is determined by a measurement of the doppler broadening which occurs when a monochromator beam of a light is scattered by air molecules. Detection of the broadened spectrum is feasible by photoelectric mixing techniques. The spectrum, which represents the Maxwell distribution of molecular velocities of the air molecules, allows determination of the air temperature profile. An analysis of the required system components is given and it is shown that due to power and stability limitations of existing lasers this technique is not yet feasible.

233. Shaw, John H., 1958: Survey of the literature on radiation in the atmosphere. The Ohio State Univ. Research Foundation, Technical Report 1. DA-36-039-SC-78153, AD 210 805. [R]

234. Shaw, John H., 1959: Theoretical analysis of radiation errors of radiosonde temperature elements. The Ohio State Univ. Research Foundation, Technical Report 2. DA-36-039-SC-78153, AD 218 342. [R]

235. Shaw, John H., 1959: Numerical evaluation of radiation errors of radiosonde temperature element ML-419 at altitudes up to 150,000 feet. The Ohio State Univ. Research Foundation, Technical Report 3. DA-36-039-SC-78153, AD 218 344. [R]

236. Shaw, John R., 1959: Methods for reducing the radiation error of the ML-419 radiosonde temperature element at altitudes up to 150,000 feet. The Ohio State Univ. Research Foundation, Technical Report 4. DA-36-039-SC-78153, AD 228 264. [R]

237. Shaw John H., 1959: Flight test results for ML-419 radiosonde temperature elements modified to reduce radiation errors. The Ohio State Univ. Research Foundation, Final Technical Report 4A. DA-36-039-SC-78153, AD 234 614. [R]

238. Shvidkovskii, E. G., 1960: Some results of measurements of the thermodynamic parameters of the stratosphere obtained with the aid of meteorological rockets. In Artificial Earth Satellites, 2, 12-19, L. V. Kurnosova, ed., Plenum Press, Inc., New York. [R]

239. Sion, E., 1955: Time constants of radiosonde thermistors. Bull. Am. Met. Soc., 36 (1), 16-21. [R]

240. Smith, Paul L., Jr., 1963: Limitations on the accuracy of sonic thermometers. Final Report, Midwest Research Institute, 62 p. AF 19(628)-473, AFCRL-63-687, AD 412 479.

Factors investigated that limit accuracy of acoustic measurements of atmospheric temperature are: variable water vapor content

and motion of air; inaccuracies in measuring transit time and acoustic path length; non-ideal behavior of the gas; and turbulence. The accuracy attainable was found to be approximately 0.5°K.

241. Smith, W., L. Katchen, P. Sacher, P. Swartz, and J. Theon, 1964: Temperature, pressure, density, and wind measurements with the rocket grenade experiment, 1960-1963. National Aeronautics and Space Administration, NASA TR R-211, 46 p.

Complete data from 28 rocket grenade experiments at Wallops Island, Virginia, and Fort Churchill, Canada, are presented. Pressures, temperatures, densities, and winds have been derived directly from the recorded times of explosions and sound arrivals, but no attempt has been made to analyze the meteorological significance of these measurements. Error analyses on 16 of the Wallops experiments are also included.

242. Stroud, W. G., W. Nordberg, and J. R. Walsh, 1956: Atmospheric temperatures and winds between 30 and 80 km. J. Geophys. Res., 61 (1), 45-56. /R/

243. Teweles, S., and F. G. Finger, 1960: Reduction of diurnal variation in the reported temperatures and heights of stratospheric constant-pressure surfaces. J. Met., 17 (2), 177-194. /R/

244. Tsvang, L. R., 1963: Nekotorye kharakteristiki specktrov temperaturnykh pul'satsii v pogranichnon sloe atmosfery. Akademiya Nauk SSSR, Izvestiya, Seriya Geofizicheskaya n 10, 1594-1600.

Some characteristics of temperature pulsations spectra in boundary layer of atmosphere; experience with airborne equipment and measurement of temperature; evaluation of temperature records. /EI/

245. Turner, H. E., and D. R. Hay, 1963: Fine structure of temperature and refractivity in the lower troposphere. Canad. J. Phys., 41 (10), 1732-1737.

Presents the results of some trial measurements with a balloon-borne probe-type capacitor refractometer, and resistance temperature sonde. Both instruments appear well suited to the study of fine structure in tropospheric air on account of their very rapid response (< 0.3 sec) and high sensitivity. Preliminary trials have already revealed the existence of atmospheric irregularities that are physically smaller than any previously measured. /PA/

246. Wagner, N. K., 1961: Theoretical time constant and radiation errors of a rocketsonde thermistor. J. Met., 18 (5), 606-614. /R/

247. Wagner, N. K., 1964: Theoretical accuracy of a meteorological rocketsonde thermistor. J. Appl. Met., 3 (4), 461-469.

The ability of the bead thermistor currently used in meteorological sounding rockets to measure the ambient kinetic temperature of the environment is examined theoretically. A non-steady state heat transfer environment including forced convection, infrared and solar radiation, compressional heating, lead wire conduction and internal heating is considered, along with normal variations to be expected in this environment. The average temperature measurement error is found to range from less than 5 C at heights below 50 km to 33.5 C at 65 km. Correction for this error should yield ambient temperature values to within ±2 percent up to 60 km with the correction accuracy decreasing to ±3.8 percent at 65 km. The correction accuracy deteriorates rapidly above 65 km suggesting that either a different type sensing element or a different sounding technique will be necessary for temperature measurement above this level.

Although theoretical temperature error was computed on the basis of mean model atmospheric temperature distributions, it is shown that the results may be applied to individual soundings as long as abrupt changes in algebraic sign of the environmental lapse rate do not occur.

248. Wagner, N. K., D. R. Haragan, K. H. John, and J. R. Gerhardt, 1961: Wind and temperature in the atmosphere between 30 and 80 km. Fourth Quarterly Technical Report, April 1, 1961 through June 30, 1961, Texas Univ. DA-23-072-ORD-1564. /A/

249. Wagner, N. K., D. R. Haragan, and J. R. Gerhardt, 1962: Wind and temperature in the atmosphere between 30 and 80 km. Seventh Quarterly Technical Report, January 1, 1962 through March 31, 1962, Texas Univ. DA-23-072-ORD-1564. /R/

250. Wood, R. D., 1959: An experimental investigation of hypersonic stagnation temperature probes. California Institute of Technology, Memorandum No. 50. AD 220 793. /R/

251. Wright Instruments, Inc., 1961: A survey for Naval Ordnance Laboratory of high altitude atmospheric temperature sensors and associated problems. Final Report-1961. N-60921-6136. /R/

WIND SENSORS

See also: Cato, G. A., 1964: Ultra-high altitude measurement systems for pressure, density, temperature, and winds. (585)

Haragan, D. R., and N. K. Wagner, 1963: Wind and temperature in the atmosphere between 30 and 80 kilometers. (213)

Miers, B., and N. J. Beyers, 1964: Rocketsonde wind and temperature measurements between 30 and 70 kilometers for selected stations. (217)

Nordberg, W., and W. Smith, 1964: The rocket-grenade experiment. (222)

Rofe, B., 1962: Mesospheric density and winds determined by the falling sphere method at Woomera. (610)

Smith, W., L. Katchen, P. Sacher, P. Swartz, and J. Theon, 1964: Temperature, pressure, density, and wind measurement with the rocket-grenade experiment, 1960-1963. (241)

Wagner, N. K., D. R. Haragan, and J. R. Gerhardt, 1961, 1962: Wind and temperature in the atmosphere between 30 and 80 kilometers. (248, 249)

252. Air Force Air Weather Service, 1954: Measuring the wind: the AN/GMD-1A. AWS Historical Study No. 3. /R/

253. Anderson, A. K., 1957: (Comments on) H. J. aufm Kampe: Upper-air wind measurements with small rockets. J. Met., 14 (5), 473-474. /R/

254. Appleman, H. S., 1961: Wind variability at 150,000 feet. Air Weather Service, AWS TR-160. AD 268 018. /R/

255. Armstrong, C. L., and R. D. Garrett, 1960: High altitude wind data from meteorological rockets. Mon. Wea. Rev., 88 (5), 187-190. /R/

256. Army Electronics Research and Development Activity, 1962: Performance characteristics of meteorological rocket wind and temperature sensors. Technical Report SELWS-M-4, 31 p.

Numerous meteorological rocket firings have been conducted at missile ranges to obtain atmospheric data in support of missile tests, and the Meteorological Rocket Network has resulted in coordinated firings designed to provide a synoptic picture of the high atmosphere. Rocket-borne inertial systems consisting of radar chaff and metalized parachutes have been utilized to determine wind flow in the altitude range from 50,000 to 250,000 ft. Fall velocities, parachute oscillations, chaff dispersion, and wind sensor lag times have been examined with radar and radiosonde ground equipment. Some of the problems involved in the temperature measuring system (Gamma) are also treated with respect to time constant, radiative effects, compressional and nosecone heating, and internal heating. Typical wind and temperature profiles are presented along with an application of the temperature profile to speed-of-sound and density calculations. /MA/

257. Arnold, A., 1948: On the accuracy of winds aloft at low altitudes. Bull. Am. Met. Soc., 29 (3), 140-141. /R/

258. Attmannspacher, W., J. Borstinger, and J. Wiehler, 1964: Preliminary results on rocketsonde measurements of wind and temperature in the upper stratosphere and in the mesosphere at Capo San Lorenzo during October/November 1963. Deutscher Wetterdienst, Report No. SR3. DA-91-591-EUC-2847.

Report on Project Cell Structure of the Atmosphere.

259. aufm Kampe, H. J., 1956: Upper-air wind measurements with small rockets. J. Met., 13 (6), 601. [R]

260. Barr, W. C., 1960: Theoretical evaluation of cylindrical chaff as a wind sensor at high altitude. U. S. Army Signal Research and Development Laboratory, USASRDL TR-2138. AD 241 876. [R]

261. Beling, T. E., D. R. Benders, and R. L. Plante, 1961: Measurement of wind shear, Final Report, covering period December 1, 1959 to June 30, 1961, United Research Inc. AD 268 948. [R]

262. Bellucci, R., 1961: Analysis of ballistic meteorological effects on artillery fire. U. S. Army Signal Research and Development Laboratory, USASRDL TR-2224. AD 268 402. [R]

263. Belmont, A., R. Peterson, and W. Shen, 1964: Evaluation of meteorological rocket data. General Mills, Inc., NASA CR-138, 96 p. NASw-558.

The published properties and accuracy of meteorological rocket and rawin systems are summarized. Rocket and rawin wind observations for about three years are compared. Eighty percent of the differences between them are within 5 m/sec, although the extremes may reach 25 m/sec. The atmospheric layer represented by each reported M/R wind varies from about 800 meters at 20 km to 2700 meters near 55 km, compared with about 1300 to 1600 meters for rawin winds below 30 km. There are no rocket data yet available to show the vertical progression of the fall reversal pr ess at high latitudes. Both rocket and rawin data agree on downward progression in spring. Recommendations are offered to enable more significant use of rocket data.

264. Beyers, N. J., 1960: Preliminary radar performance data on passive rocket-borne wind sensors. IRE Trans. on Military Electronics, MIL-4, 230-233. [R]

265. Beyers, N. J., and O. W. Thiele, 1960: Meteorological rocket wind sensors. U.S. Army Signal Missile Support Agency, White Sands Missile Range, Special Report 41. AD 242 764. [R]

266. Beyers, N. J., and O. W. Thiele, 1961: Meteorological rocket wind sensors. In Initiation of the meteorological rocket network. Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised, p. 91. /R/

267. Beyers, N. J., and O. W. Thiele, 1961: Performance characteristics of systems for high altitude wind and temperature observations. Instrument Society of America, Fall Instrument-Automation Conference and Exhibit, Los Angeles, California, September 11-15, 1961, Preprint No. 170-LA-61. /R/

268. Borgiasz, W. B., 1962: AN/FMQ-6 passive target high altitude wind sensing equipment. Final Report, Marquardt Corp., Report No. 3, 86 p. DA-36-039-SC-84921, AD-412 848.

A resume of the entire project is presented along with discussions of the operational and technical problems and the contractor's method of approach to these problems and their resolution. Graphical plots, illustrations, and tables of flight are presented. Analysis of tests are discussed. Over-all conclusions are given.

269. Bruch, A., G. M. Morgan, Jr., and J. E. Miller, 1961: Wind variability in the mesosphere as determined by the tracking of falling objects: an evaluation and preliminary results. New York Univ. AF 19(604)-6193, AFCRL 660, AD 261 713. /R/

270. Case, Bettye Anne, 1963: Con ter evaluation of winds from meteorological rocketsonde measurements. Marshall Space Flight Center, NASA-TM-X-51743, 22 p.

This report presents a method for determining wind and wind shear measurements, ground track, and fall rate of target from radar measured spherical position coordinates of a descending target. Due to errors inherent in the original measurements, it is considered that this method produces more representative values for altitude levels widely spaced with respect to time-sequenced data records than methods using interpolations. These computational procedures provide a means for excluding only time records determined erroneous in a given observation. The final tabulations give measurements that

are averaged over approximately 500-meter layers, and centered at the designated altitude level. Since data at altitude levels from 30 to 70 km are relatively sparse, the desire to use all the representative data in a given observation, even if it contained some obviously erroneous time records, led to the application of certain arbitrary mathematical standards for acceptable raw data. The theory involved in the data editing and evaluation procedures is discussed. The method is currently in use to evaluate data for a number of rocketsonde observations as well as for rocketsonde measurements used in flight evaluations. /STAR/

271. Caton, P. G. F., 1963: Wind measurement by Doppler radar. Met. Mag., 92 (1092), 213-222.

A method is presented for the measurement of upper winds in precipitation conditions by Doppler radar. By combining wind components observed at 10° intervals of azimuth over a wide sector, mean wind speed and direction may be measured at a number of heights simultaneously and the variation of wind both in space and time may be investigated. Observations obtained during the advance of two warm fronts have been analyzed. The application of the Doppler technique to the measurement of convergence is examined and preliminary results described.

272. Champion, K. S. W., and S. P. Zimmerman, 1962: Winds and turbulence at 200,000 to 400,000 feet from chemical release. In National Symposium on Winds for Aerospace Vehicle Design, Proceeding, U.S. Air Force Cambridge Res. Labs., Air Force Surveys in Geophysics, No. 140, 2, 225-235. AFCRL-62-273(II).

Chemicals released from rockets into the upper atmosphere provide an excellent method of measuring atmospheric winds and studying eddy sizes and other properties of turbulence. Although the data presented in this paper lies in the range 200,000 to 400,000 ft, this method can be used over a much wider range, probably between 100,000 and 1,500,000 ft. Optical methods can be used to track the chemicals (gases or very fine solid particles) if they are sunlit or self luminous. The chemicals are self luminous if they are at a high temperature (as the result of an explosion) or if they emit light as a result of chemical reactions with atmospheric constituents. Radar methods (for example, ionosondes) can be used for tracking if these clouds are ionized. Wind and turbulence data are presented which were obtained using both of these techniques. Wind speeds as high as 400 ft/sec are frequently observed and wind shears of about 0.02 ft/sec extending over 10,000 to 20,000 ft of altitude, are common. Considerable turbulence is observed in the altitude region 200,000 to 370,000 ft. At altitudes just above 370,000 ft, the atmosphere appears to be quite stable. This is probably due to the eddy Reynolds number becoming quite small and to the large positive temperature gradient resulting in Richardson's number becoming large. At 300,000 ft the diameters of large scale eddies are as large as 6000 ft and eddy diameters as small as 10 ft have been observed. These observations are in general agreement with the theory of Booker.

273. Cline, D. E., 1957: Rocket-beacon wind-sensing system. U.S. Army Signal Engineering Laboratories, Engineering Report E-1205. AD 137 787. /R/

274. Cline, D. E., 1958: Double-direction-finding rocket meteorological sensing system. U. S. Army Signal Research and Development Laboratory, USASRDL TR-1981. AD 212 478. /R/

275. Das, S. K., A. V. Raju, and S. Mull, 1961: Frequency modulated rawinsonde. Indian J. Met. Geophys., 12 (4), 623-628.

This paper describes a method of frequency modulating a 500 mc/s UHF transmitter by utilizing the ionizing properties of a neon tube to change the terminating impedance of a transmission line (tank circuit) periodically. With this method a 400 mc/s transmitter can be used for both radiosonde and radio wind-finding work. The paper also describes how the method has been adapted to telemeter radiosonde data. Brief description of the relay circuits and changes in the design of radio theodolite receiver (ground equipment for radio wind-finding) for recording the data is given.

276. de Jong, H. M., 1958: Errors in upper-level wind computations. J. Met. 15 (2), 131-137. /R/

277. Ellsaesser, H. W., 1960: Wind variability. Air Weather Service, AWS TR-105-2. AD 242 199. /R/

278. Engler, N. A., and J. B. Wright, 1962: Wind sensing capability of the ROBIN. In National Symposium on Winds for Aerospace Vehicle Design, Proceedings, U.S. Air Force Cambridge Research Lab., Air Force Surveys in Geophysics No. 140, 2, 127-150. AFCRL-62-273(II). /R/

279. Giorgi, S., 1963: Dynamics of the upper atmosphere. Ann. Geofis., 16, (4), 543-555.

The problem of wind determination in the atmosphere by the sodium and lithium cloud technique is considered and a review is presented of the data reduction methods most commonly used in various countries. Particular attention is devoted to the Italian method which is illustrated in some detail in order to provide a complete solution to the problem. /PA/

280. Gul'medov, Kh., 1963: Turbulence of the atmosphere indicated by optical observations of meteor trails at Ashkhabad and Kazan'". Geomagnetizm i Aeronomiya (Geomagnetism and Aeronomy), 3, (2), 309-314.

281. Henry, R. M., and G. W. Brandon, Jr., 1961: The use of smoke trails as wind sensors. Instrument Society of America, Fall Instrument-Automation Conference and Exhibit, Los Angeles, California, September 11-15, 1961, Preprint No. 174-LA-61. /R/

282. Henry, R. M., G. W. Brandon, H. B. Tolefson, and W. E. Lanford, 1961: The smoke trail method for obtaining detailed measurements of the vertical wind profile for application to missile-dynamic-response problems. National Aeronautics and Space Administration, NASA TN D-976. /R/

283. Hudson, G. E., S. Weisbrod, J. L. Heritage, and J. Zane, 1957: A study of high altitude wind research, Part I: methods and bibliography. Final Technical Report June 12, 1956-January 12, 1957, Smyth Research Associates. AD 128 911. /R/

284. Ingman, Lassi, 1961: Radiotheodolite recording receiver, type RT 16. Vaisala News, 11, 4-8.

The Vaisala Oy radiotheodolite is a phase and frequency measuring and recording device for electronic determination of upper air winds. The device includes the following sub-systems which form a complete radio wind instrument: radiotheodolite recording receiver, antenna set, and radio wind computation equipment. Mechanical and electrical construction is discussed, the latter in some detail and a block diagram of the overall electronic set-up is included.

285. Jenkins, C. F., 1952: A survey of available information on winds above 30,000 feet. U.S. Air Force Cambridge Research Center, Air Force Surveys in Geophysics No. 24, 35 p.

This report is intended to present the existing knowledge of the winds above 30,000 feet. The results of many methods of wind measurement have been reviewed and combined, in order to obtain as complete a picture of the flow patterns as is possible.

286. Jenkins, K. R., 1962: Empirical comparisons of meteorological rocket wind sensors. J. Appl. Met., 1 (2), 196-202. /R/

287. Jenkins, K. R., and W. L. Webb, 1959: High-altitude wind measurements. J. Met., 16 (5), 411-515. /R/

288. Jiusto, J. E., and W. J. Eadie, 1963: Terminal fall velocity of radar chaff. J. Geophys. Res., 68 (9), 2858-2861.

Approximation method shown for analytically predicting fall velocity of cylindrical chaff over limited Reynolds number range yields results in close agreement with observations; chaff fall velocity in lower atmosphere is only moderately sensitive to air temperature and viscosity; pressure is dominant variable; spread in chaff fall velocity about mean value can be considerable, depending in large measure on degree of chaff deformation and clustering of dipoles. /EI/

289. Johnson, D. E., and E. E. Sartor, 1961: Wind-measuring set AN/TMQ-13 (XE-2), U. S. Army Signal Research and Development Laboratory, USASRDL TR-2225. AD 268 403. [R]

290. Johnston, Kenneth D., 1962: Response of spherical balloon to wind gusts. Marshall Space Flight Center, NASA TM-X-51710, 20 p.

This report demonstrates the feasibility of measuring large wind gradients, or shears, by tracking a spherical balloon with radar as the balloon responds to these wind gusts. To determine how closely the balloon would follow the swiftly changing wind it was necessary to find the buoyancy, gravity, and aerodynamic drag of the balloon. An important criterion in the recording by radar of the wind profile is the difference between peaks for a given wind gust. Velocities, altitude, and peak differences are plotted, and formulas are given for a number of findings. [STAR]

291. Kantor, Arthur J., 1962: Wind climatology at boost glide altitudes. In National Symposium on Winds for Aerospace Vehicle Design, Proceedings, A. F. Cambridge Research Lab., Air Force Surveys in Geophysics No. 140, 2, 215-223. AFCRL-62-273(II).

Available rocket wind data above 25 km compare favorable with radiosonde data in the 25 to 30 km range of overlap. Seasonal component and vector means for 6 stations indicate a level of maximum winds at 50 to 70 km in summer and 60 to 70 km in winter. Standard deviations of components are consistently larger in winter than in summer at all stations and at most heights. Variability seems to be greatest at 65 to 75 km in summer. Less than one percent of the rocketsonde observations show, a wind shear greater than approximately .02/sec over a 3-km thickness. [MA]

292. Keegan, T. J., 1962: Synoptic patterns at 100,000 to 200,000 feet. In National Symposium on Winds for Aerospace Vehicle Design, Proceedings, A. F. Cambridge Research Lab., Air Force Surveys in Geophysics No. 140, 2, 195-210. AFCRL-62-273(II). [R]

293. Killen, G. L., 1960: Balloon behavior experiments. U.S. Army Signal Research and Development Laboratory, USASRDL TR-2093. [R]

294. Kirkman, R. A., and J. M. LeBedda, 1948: Meteorological radio direction finding for measurement of upper winds. J. Met., 5, 28-37. /R/

295. Knapp, H. W. P., 1962: The determination of wind structure at low altitudes by the use of smoke trails. Royal Aircraft Establishment, Technical Note IR. 8. AD-292 054.

A method of measuring wind structure up to an altitude of 500 feet is described. The evaluation of the results is discussed.

296. Kocharski, A. B., 1956: Wind, temperature, and their variabilities to 120,000 feet. Air Weather Service, AWS-TR-105-142. AD 107 275. /R/

297. Lally, V. E., and R. Leviton, 1958: Accuracy of wind determination from the track of a falling object. A. F. Cambridge Research Lab., Air Force Surveys in Geophysics No. 93. AD 146 858. /R/

298. Lanford, Wade E., T. W. Perry, Jr., Hal T. Baber, Jr., and F. W. Booth, 1963: Development of a smoke-trail vehicle for application to wind-shear measurements up to 80,000 feet. National Aeronautics and Space Administration, NASA TN-D-2009, 26 p.

A reliable, inexpensive, and relatively simple smoke-generating vehicle has been developed for extensive use at several missile ranges in a detailed wind-shear-measurement program. Details of the vehicle, which is capable of producing a luminiferous trail between the altitudes of 6,000 and 80,000 feet, are presented along with those of several other vehicles considered.

299. Lanford, Wade E., Joseph J. Janos, and Hal T. Baber, Jr., 1964: Comparison and evaluation of several chemicals as agents for rocket-vehicle production of smoke trails for wind-shear measurements. National Aeronautics and Space Administration, NASA TN D-2277, 27 p.

An investigation was made to determine the relative merits of four smoke-producing chemicals. Results of ground tests of one chemical and flight tests of three others are presented. These three

chemicals are evaluated with regard to brightness and persistence interval of trails produced under identical conditions and, also, with regard to operational and handling considerations. Relative humidity and other effects on the trail are also discussed. These tests also verify the assumption that response of a smoke trail to wind movement is nearly perfect.

300. Lees, Sidney, and E. E. Larrabee, 1959: Structural studies and component developmer. Third Quarterly Report, Jan. 1-May 31, 1959, United Research, Inc. DA-36-039-Sc-75064.

The present report is concerned with the development of a suitable minimum weight structure for the wind shear probe, with the internal instruments and the telemetering link. Pertinent material is gathered, discussed and extensively illustrated. The main subject headings are as follows: 1) wind shear measurement system; 2) second digital computation study of the wind shear probe; 3) final analysis of the non-instrumented drop test results; 4) experimental investigation-Azimuth indicator; 6) accelerometer requirements; and 7) consideration of the telemetering subsystem.

301. Lees, Sidney, and R. L. Weddleton, 1959: Component development. Fourth Quarterly Report, June 1 - Aug. 31, 1959, United Research, Inc. DA-36-039-Sc-75064.

The report gives the schedules and procedures for the manufacture of wind shear probe structures, the concepts and background of a wind shear measurement system, the design of probe structural components, the theoretical basis for the probe and the telemetering system. A discussion of the results of some field tests of wind shear probes is included. The authors give a re-evaluation of the effect of ozone thickness upon wind shear measurement. It is concluded that the accelerometer response corresponds to wind difference rather than to wind shear for small ozone thickness. An interpretation is given for wind difference corresponding to 0.001 g at all altitudes and is considered most useful at upper altitudes.

302. Lenhard, Robert W., Jr., and Margaret P. Doody, 1963: Accuracy of meteorological data obtained by tracking the ROBIN with MPS-19 radar. A. F. Cambridge Research Labs., Instrumentation for Geophysics and Astrophysics No. 35, 15 p. AFCRL-63-938, AD 434 379.

A sample of 32 ARCAS-ROBIN rocket soundings that were tracked simultaneously by FPS-16 and MPS-19 radars was examined to determine the accuracy of meteorological data obtained from the less accurate radar, the MPS-19. The root-mean-square error in winds determined by the MPS-19 increased with altitude in a reciprocal relationship from 5 mps at 30 km to 45 mps at 70 km; it was less than 10 mps at all levels below 55 km. No evaluation of the accuracy of thermodynamic data was possible. Any such data obtained from an MPS-19 track will be rejected under the criteria of the existing data reduction program as being from a target that failed to inflate.

303. Lenhard, Robert W., Jr., and J. B. Wright, 1963: Mesospheric winds from 23 successive hourly soundings. A. F. Cambridge Research Labs., AFCRL-63-836, 81 p. AD 417 441.

Wind information between 30 and 70 km was obtained from 23 successive hourly rocket soundings made at Eglin AFB, Florida, on 9-10 May 1961. The sensor was a 1-m mylar balloon (ROBIN) tracked by FPS-16 radar. Equations for the component wind speed are developed from the basic equations of motion of the balloon and appropriate simplifications. The balloon velocities and accelerations from which winds are derived are obtained by linear smoothing techniques applied to radar-observed position and derived velocity data. The smoothing technique is described in detail. This data reduction process yields wind with an rms vector error of 2 mps at the top of the sounding, decreasing as the balloon falls so that a representative value is about 1 kt. The errors increase in the case of an uninflated balloon to 5 mps maximum and 5 kt for the representative value. The variance of the observed winds is largely accounted for by diurnal and semidiurnal oscillations. The amplitude of the oscillations increases with altitude and is greater for the diurnal than for the semidiurnal oscillation. These oscillations result in a greater lag variability of wind at 8 to 12 hr than at 24 hr lag. Comparison of the residual variance at several levels suggests the existence of a turbulent zone in the upper ozonosphere, just below the stratopause.

304. Leviton, R., 1962: A detailed wind profile sounding technique. In National Symposium on Winds for Aerospace Vehicle Design, Proceedings, U.S. Air Force Cambridge Research Labs., Air Force Surveys in Geophysics No. 140, 1, 187-195. AFCRL-62-273(I). /R/

305. Lhermitte, Roger M., 1962: Note on wind variability with Doppler radar. J. Atmospheric Sci., 19 (4), 343-346.

The author describes the principles and operation of the scheme proposed by LHERMITTE and ATLAS (Ninth Weather Radar Conference, Boston, American Meteorological Society, 1961) for measuring the horizontal and vertical motions of detectable particles in widespread rain or snow conditions by means of pulse Doppler radar, and an improvement of this method involving the direct recording of radial motion as a function of both azimuth and altitude. A continuously rotating beam and a slowly moving range gate are used. The time allowed for the gate to move from 0-40,000 ft is 6 min; during this time the radar beam performs 60 complete revolutions in the azimuth giving 60 VAD (Velocity-Azimuth Display) patterns, each referring to successively higher altitudes. "Since the altitude gate is continuously moving, the measurements will be related to the average wind in the altitude interval scanned by the gate during one complete revolution of the antenna". If the average radial velocity $\bar{v}$ is given as a voltage and recorded, each azimuth cycle will bring 2 maxima, one corresponding to $\bar{v}_h \cos\alpha - \bar{v}_f \sin\alpha$ and the higher one coresponding to $\bar{v}_h \cos\alpha + \bar{v}_f \sin\alpha$. Two curves as a function of height will be obtained by combining the higher and lower maxima directly on the record. Their average will be $\bar{v}_h \cos\alpha$ and their difference $2\bar{v}_f \sin\alpha$. The results of measurements and computation are presented and analyzed. /MA/

306. Maeda, Ken-ichi, Yoshio Takeya, Haruya Matsumoto, et al., 1961: Atmospheric temperature and wind measured by the Kappa rocket. In International Symposium on Rockets and Astronautics, 2nd, Tokyo, 1960, Proceedings, 276-278.

Seven Kappa-VI rockets were fired by the Institute of Industrial Science of the Tokyo University at Michikawa from June 1958 to March 1959 for measuring temperature and wind. The results obtained with Kappa-TW-V and VI were reported and tabulated. The temperature distribution was characterized in two patterns of summer and winter types and shown in graphs. The winter pattern has a peak at the meso region of about 50 km and an inverse peak at about 30 km. The summer pattern has an inverse peak at about 10 km or no inverse peak. Further research is under way.

307. Manring, E., J. Bedinger, H. Knaflich, and D. Layzer, 1964: An experimentally determined model for the periodic character of winds from 85 to 135 km. Geophysics Corporation of America, NASA CR-36, 110 p.

Since 1959, measurements of upper atmosphere winds have been made from Wallops Island, Virginia, utilizing the sodium vapor technique. To date, measurements from 22 different vapor trails have been analyzed. In the height range 85 to 135 km, the measurements show that the winds have large quasi-periodic components. Analysis shows that the 8-hour component is dominant over the entire range. A new picture of the wind structure at these altitudes is proposed.

308. Mantis, Homer T., 1963: The structure of winds of the upper troposphere at mesoscale. J. Atmospheric Sci., 20 (2), 94-106.

Spectra of the variance of horizontal velocities derived from the trajectories of superpressure altitude-controlled balloons have been obtained in the frequency range 0.005 to 0.5 cy min^{-1}. With the aid of other constant-altitude balloon data, a spectrum of velocity variance of the upper tropospheric winds is proposed for a range of frequencies termed mesoscale, which is meant to describe scales of motion just smaller than synoptic scale but larger than the motions usually referred to as turbulence. The mesoscale spectra all decrease sharply with frequency at frequencies just above synoptic scale to a frequency of about 0.1 cy min^{-1}, where an irregular increase sets in. The spectra continue to rise to the highest frequencies analyzed, pointing to a second spectral maximum in the turbulent regime. The spectra have been used to estimate the non-representative mesoscale standard deviation of the upper winds of 7 to 17 knots. A horizontal diffusivity by mesoscale motions is estimated to be of the order of 10^9 cm^2 sec^{-1}.

309. Masterson, John E., William E. Hubert, and Thomas R. Carr, 1961: Wind and temperature measurements in the mesosphere by meteorological rockets. J. Geophys. Res., 66 (7), 2141-2151. /R/

310. Masterson, John E., William E. Hubert, and Thomas R. Carr, 1961. Wind and temperature data measured by meteorological rockets at Point Mugu, California. In International Symposium on Rockets and Astronautics, 2nd, Tokyo, 1960, Proceedings, 279-287.

Small solid propellant rockets carrying meteorological instrumentation were launched from Point Mugu (Calif.) for measuring temperature and wind at altitudes exceeding 70 km and for revealing unknown relationships between processes in the mesosphere and weather in the troposphere. At peak altitude the rocket ejected a metalized wind-sensing parachute which was tracked on descent by radar for obtaining wind velocities. A transmitter from a radiosonde provided temperature measurements. The data for analysis of atmospheric circulation were presented in tables and graphs.

311. Miller, Paul H., 1959: A proposed rabal system for the rapid acquisition of high-altitude wind data. U.S. Naval Ordnance Test Station, NOTS TP-2325. /R/

312. Miller, Paul H., 1963: A description of instrumentation and methods used for making double-rawin soundings at the U.S. Naval Ordnance Test Station. U.S. Naval Ordnance Test Station, NOTS TP 3242, 14 p. AD 411 815.

The unique double-rawin complex and associated IBM 7090 data-reduction techniques developed at the U.S. Naval Ordnance Test Station to obtain more accurate winds-aloft data are described. Schematic diagrams of the electronic modifications and additions to standard equipment, together with the IBM 7090 data-reduction program, are presented.

313. Moore, C. B., J. R. Smith, and A. Gaalswyk, 1954: On the use of constant-level balloons to measure horizontal motions in the atmosphere. J. Met., 11 (3), 167-172.

In the course of government-sponsored work in the development of the constant-level balloon, the writers supervised many constant-level balloon flights on the standard meteorological surface of 300 millibars. The tracks of these flights are of general meteorological interest, as they are believed to delineate the actual trajectory of an equivalent mass of air traveling on a constant-pressure surface. Some of the original flight data are presented for the information of other investigators of air motion, and to illustrate the application of constant-level balloons to meteorological problems, particularly atmospheric diffusion and the variability of the wind. Suggestions are made regarding the significance of the data presented, and further experiments are proposed which might result in a better understanding of the mechanisms of air motion. Possible applications of constant-level balloons in routine observations, to obtain representative measurements of wind velocity, are set forth.

314. Müller, Hans Gerhard, 1961: Höhenwindmessverfahren [Upper wind measurement equipment]. In Handbuch der Aerologie. Hesse, Walter (ed.), Leipzig, Geest & Portig, 587-621.

The entire field of wind aloft measurements by several systems is reviewed: cloud movement, kite and captive balloon measurements, airplane wind measurements, pilot balloon or free balloon wind determinations; properties of aerological balloons, filling, rate of ascent; optical systems (theodolites and computation for single and double theodolite ascents and the trail method); radio methods of several types: triangulation, location from a single station, reflection and impulse or radar systems. Useful tables are included and systems or equipment illustrated.

315. Murgatroyd, R. J., 1957: Winds and temperatures between 20 km and 100 km - a review. Quart. J. Roy. Met. Soc., 83 (358), 417-458. [R]

316. Murrow, H. N., and L. E. Barker, Jr., 1961: An analytical study of the wind-following characteristics of a parachute at high altitudes. Instrument Society of America, Fall Instrument-Automation Conference and Exhibit, Los Angeles, California, September 11-15, 1961, Preprint No. 169-LA-61. [R]

317. Otterman, J., 1958: A simplified method for computing upper-atmosphere temperature and winds in the rocket-grenade experiment. Technical Report, Michigan Univ. Engineering Research Institute. DA-36-039-SC-64659, AD 201 454. [R]

318. Pearson, P. H. O., 1962: Some measurements of winds in the upper atmosphere at various seasons, 1961-1962. Weapons Research Establishment (Australia), SAD-100, 33 p.

Measurements of winds in the region between 220,000 ft and 90,000 ft have been obtained at Woomera from three firings of upper atmosphere research rockets during summer, au- -n, and winter periods in conjunction with the falling sphere method of measuring density. The winds were obtained by continuing to track the spheres with FPS-16 radars below the region in which density measurements could be obtained. These values are presented together with the response calculations to wind velocity for the spheres, wind velocity and direction below 120,000 ft obtained from meteorological balloons, and the general weather pattern over Australia for the firing times. /STAR/

319. Phillips, Norman S., T. W. Temple, and M. G. Passaniti, 1962: Measurement of wind shear. First Quarterly Report July 1-Sept. 31, 1962, Technology Inc., Report No. 1, 46 p. DA 36-039 SC-90854,

This report covers the initial steps taken to improve the wind shear measuring system specified in Signal Corps Technical Requirements SCL-5874. The background of the wind shear measurement system is discussed with a description of the components and their functions. Aerodynamic properties of the probe are investigated and modifications introduced which will increase the drag and stability. Full monocoque construction has been selected as the most efficient means of constructing the probe and a structural design is presented. The instrumentation system consists of state-of-the-art techniques and sensors, and utilizes a pulse-duration-modulation encoder. Ground logic system components have been thoroughly studied and design details are under development. /MA/

320. Pierce, Russell M., Jr., 1962: Wind measuring set AN/GMQ-20(v) system evaluation. U.S. Air Force Cambridge Research Labs., AFCRL-62-1110, 36 p.

This report discusses the results of tests performed at AFCRL to determine the operation and accuracy of the individual components of the Wind Measuring Set AN/GMQ-20(v), when interconnected in any combination up to ten transmitters and eight indicators and/or recorders, and operated as a complete system under simulated field conditions. The evaluation of 50/60-cycle transmitter and receiver synchros for use in the applicable components of the set is also included. A list of the tests performed during the evaluation of both the system and the synchros is given, and includes test results and recommendations. The tests indicated that these synchros and all of the set components, excluding the Recorder RO-141/GMQ-20, are reliable and accurate. /STAR/

321. Pilié, R. J., J. E. Jiusto, and R. R. Rogers, 1963: Wind velocity measurement with Doppler radar. In Weather Radar Conference, 10th, Washington, D. C., April 1963, Proceedings, 329a-329L.

A wind measurement concept was formulated in which two Doppler radars are used to sense the motion of chaff introduced into the atmosphere. In determining the feasibility of this concept, exploratory field experiments were conducted with a single Doppler radar of modest performance characteristics. Comparative wind data obtained from the radar technique, by smoke trail photography, and by standard radiosonde methods, are presented. /MA/

322. Plagge, H. J., and L. B. Smith, 1956: Project Rawijet - a study of the wind variability in space and time at the Salton Sea Test Base. Sandia Corporation, SC-3880 (TR). /R/

323. Ragsdale, George C., and Peter E. Wasko, 1963: Wind flow in the 80-400 km altitude region of the atmosphere. National Aeronautics and Space Administration, NASA TN-D-1573, 36 p.

An attempt is made in this report to deduce the wind characteristics in the 80 to 400 km ionospheric region of the atmosphere for the purpose of establishing wind input data for launch vehicle and spacecraft design and performance studies. Although the amount of wind data available is far from that desirable for such an undertaking, there is a sufficient amount of data to give at least an indication of the probable wind characteristics at these high atmospheric levels. In this report the most important wind measurement techniques are described, the wind data obtained from recent rocket techniques and from a literature survey of ionospheric drift measurements are presented. The probable maximum wind speed envelope is established, the wind shears are determined, and some general wind flow characteristics are deduced.

324. Rapp, R. R., 1960: The accuracy of winds derived by the radar tracking of chaff at high altitudes. J. Met., 17 (5), 507-514. [R]

325. Reisig, Gerhard H. R., 1956: Instantaneous and continuous wind measurements up to the higher stratosphere. J. Met., 13 (5), 448-455. [R]

326. Reiter, E. R., 1958: The layer of maximum wind. J. Met., 15 (1), 27-43. [R]

327. Rofe, Bryan, 1960: Wind determination using a falling body as a sensor with particular reference to window. Weapons Research Establishment (Australia), SAD-64, 18 p.

Winds in the 220,000 ft and the 160,000 ft regions were obtained by the radar tracking of window ejected from an Aeolus sounding rocket fired at Woomera on March 23, 1960. The winds determined gave zonal components of 175 ft/sec and with small shears at 220,000 ft. Large shears at 160,000 ft were determined, but the accuracy of the wind find at this height using copper window was suspect. The theory of the response of a falling object to a wind is developed, and from the figures obtained in this experiment the suitability of nylon window as a sensor in the 220,000 ft region is established. The meteorological situation at the time of firing is discussed and some horizontal temperature gradients are obtained using the thermal wind equation. [MA]

328. Rosenberg, N. W., D. Golomb, and E. F. Allen, Jr., 1963: Chemiluminescent techniques for studying nighttime winds in upper atmosphere. J. Geophys. Res., 68 (10), 3328-3330.

Two different types of payload for generating persistent, glowing trails under full night conditions have recently been designed, flown and evaluated; photographs of trails can be treated by triangulation techniques to obtain mass motion parameters throughout night; first type of payload is based on chemiluminescent reactions of vaporized aluminum with oxygen of upper atmosphere; second type on reaction of atomic oxygen with nitric oxide. [EI]

329. Salmela, H. A., 1960: Wind speeds from GMD-1 ascents computed electronically compared to plotting board results. U.S. Air Force Cambridge Research Labs., GRD Research Notes No. 47. AFCRL-TN-60-804. [R]

330. Sandlin, Roy E., Jr., 1963: An analysis of wind shear differences as measured by AN/FPS-16 radar and AN/GMD-1B rawinsonde. Army Electronics Research and Development Activity, Environmental Sciences Dept., ERDA-68, 24 p. AD-417 573.

Wind shear in the lower 35,000 feet (11 km) of the atmosphere has been investigated with AN/FPS-16 radar by tracking small corner reflectors attached to standard rawinsonde flights. An analysis of a selected group of flights during the 1962-63 winter season at White Sands Missile Range, New Mexico, has revealed significant differences in values of wind shear as computed from AN/GMD-1B equipment.

Shear values from AN/FPS-16 data are found to be significantly greater than AN/GMD-1B values in 300 and 600 foot increments but become insignificant in 1000-foot increments.

331. Sandlin, Roy E., Jr., and Elias M. Armijo, 1964: An analysis of AN/FPS-16 radar and AN/GMD-1B rawinsonde data differences. Army Electronics Research and Development Activity, ERDA-115, 41 p. AD-432017.

A series of rawinsonde balloon flights has been tracked simultaneously by AN/GMD-1B rawin and AN/FPS-16 radar. The data acquired have been analyzed for height, wind speed, wind direction, and angular error under field operational conditions. Differences have been tabulated through the first 35,000 ft of the atmosphere and have shown significant AN/GMD-1B errors (under the assumption that AN/FPS-16 data are optimum). Mean error values are shown in order to establish a bias, and rms deviation of error is shown as an indicator of precision of the AN/GMD system. [STAR]

332. Scoggins, James R., 1963: High resolution wind measurement - launch design problem. Astronautics & Aerospace Eng. 1 (3), 106-107.

Development of 2 systems for measuring winds in atmosphere to altitudes above maximum dynamic pressure region (10-14 km) for use in vehicle design and performance analyses; in smoke-trail/photographic method, wind measurements are made by establishing vertical column of smoke by means of small rocket and photographing motions of trail; in radar/spherical balloon technique, measurements are made by releasing radar-reflective balloon and skin-tracking it with precision ground based radar; characteristics of wind speed profiles measured by 2 techniques. /EI/

333. Scoggins, James R., 1963: An evaluation of detail wind data as measured by the FPS-16 radar/spherical balloon technique. National Aeronautics and Space Administration, NASA TN D-1572, 30 p.

This report presents a method for obtaining detail wind and wind shear measurements using the FPS-16 radar/spherical balloon technique, and an error analysis of the wind data. Theory for reducing radar tracking data (azimuth, range, and elevation) to obtain wind data, and reduction techniques employing different smoothing procedures, are presented. A sample of reduced data is included to illustrate the data reduction technique and the capability of the system for making detail wind measurements. Two techniques for reducing tracking data to obtain wind data are presented. These consist of statistical and polynomial approaches for eliminating measurement errors in the tracking data. It is shown that average wind speeds over 50-meter altitude intervals can be measured with a maximum RMS error of about 0.8 m/sec at altitudes where maximum wind speeds normally occur (~12 km at Cape Canaveral), and a maximum RMS shear error over 50 meters of 0.023 sec^{-1}.

334. Scoggins, James R., 1964: Aerodynamics of spherical balloon wind sensors. J. Geophys. Res., 69 (4), 591-598.

A preliminary analysis of the response characteristics of spherical balloon wind sensors is presented. It is shown that smooth superpressure spheres do not provide accurate detailed wind profiles and that the response characteristics can be improved by the addition of roughness elements. Experimental data show that surface roughness elements on a spherical balloon stabilize the drag force vector and reduce the lift force. Spurious aerodynamically induced motions are significantly reduced, and the balloon more accurately senses the true wind.

335. Scoggins, James R., 1965: Status of Jimsphere development. Bull. Am. Met. Soc., 46 (1), 21.

This letter describes recent progress in the development of inflated spheres for detailed wind profile measurements up to 20 km. It has been found that smooth spheres do not rise vertically in a quiet atmosphere at supercritical Reynolds numbers. Adding roughness elements to the surface of the sphere is observed to increase the aerodynamic stability of the rising sphere. Wind profiles measured using spheres stabilized with roughness elements molded into the skin (called Jimspheres) are found to have essentially the same spectrum and variability at high frequencies as simultaneously measured smoke trail profiles. Work continues to ascertain the optimum configuration and arrangement of roughness elements.

336. Sissenwine, Norman, 1958: Development of missile design wind profiles for Patrick AFB. U.S. Air Force Cambridge Research Center, Air Force Survey in Geophysics No. 96, 17 p. AFCRC-TN-58-216, AD-146 870.

Reviews the application of wind profiles in missile design and presents two methods of providing such info. Of the two methods, wind profiles are the most readily used but they do not have universal application to all missile problems. The other method, refined wind statistics which include standard deviations of the wind components at all levels and correlation between levels does have universal application but is more difficult to use. Included are illustrations of 1, 5, 10, and 20 percent design wind profiles for Patrick AFB. They were derived from wind shears observed with the latest wind sounding equipment, the AN/GMD-2, and from AN/GMD-1 very high altitude wind soundings reported by the Air Weather Service for Patrick AFB.

337. Smith, F. J., 1964: The measurement of high altitude wind velocities from vapour releases. II. The Queen's University of Belfast, AFCRL-64-225, (processed), 21 p. AD 430 498.

A digital computer method is described for determining accurately and quickly the position in space of either a luminous vapour trail or a small luminous vapour cloud. The position is found by analysing data from photographs of the object and of the star field from at least two camera positions. A correction is included to take account of the curvature of the earth's surface.

338. Smith, Lawrence B., 1954: A study comparing winds aloft measuring equipment at Salton Sea Test Base. Sandia Corporation, U.S. Atomic Energy Commission SC-3512 (TR) Instrumentation. /R/

339. Smith, Lawrence B., 1960: The measurement of winds between 100,000 and 300,000 ft by use of chaff rockets. J. Met., 17 (3), 296-310. /R/

340. Smith, Lawrence B., 1960: Use of chaff rockets for measurements of high-altitude winds. Presented at the American Rocket Society 15th Annual Meeting, Washington, D. C., December 5-8, 1960, Reprint No. 1468-60. /R/

341. Smith, Lawrence B., 1962: Monthly wind measurements in the mesodecline over a one-year period. J. Geophys. Res., 67 (12), 4653-4672.

Variations in winds between altitudes of 180 and 275 kilofeet are shown over a 1-yr period as a result of 38 observations made at the Tonopah test range in Nevada. These observations were made by radar tracking of chaff ejected from small two-stage rockets above 300 k. ft. Two to four measurements were made on day each month throughout the year except during February and Oct. Measurement accuracy, fall behavior from free fall to terminal velocity seasonal distributions, annual variations, and vertical wind shear statistics are discussed. Negative results were obtained in effort to correlate periodicities with tidal motions and in attempts to quantify turbulence directly. However, the vertical scale of turbulence from correlation curves is found to vary from about 25 k. ft in winter to 45 k. ft in summer. The decay of correlation curves are compared with those from other altitude zones. Root mean square variations of turbulence estimated from the radar track are approximately 21 knots. /MA/

342. Strom, J. A., and T. G. Weathermon, 1963: NB-66B high altitude gust survey: technical analysis. Final Report, Douglas Aircraft Co., Inc., ASD TDR63 145, 1, 259 p. AD-413 270.

Introductory and explanatory information are given pertaining to the quantitative data gathered with a gust measuring NB-66B aircraft during high altitude storm penetrations made as a part of the 1961 National Severe Storms Project. The data presented include power spectrum plots of the three axes gust velocities and frequency distributions of the peaks.

343. Tolefson, H. B., 1962: Smoke-trail measurements of the vertical wind profile and some applications. In National Symposium on Winds for Aerospace Vehicle Design, Proceedings, U.S. Air Force Cambridge Research Labs., Air Force Surveys in Geophysics, No. 140, 1, 203-219. AFCRL-62-273 (I). /R/

344. Tsvang, L. R., S. L. Zubkovskii, V. N. Ivanov, F. Ya. Klinov, and T. K. Kravchenko, 1963: Izmereniya nekotorykh kharakteristik turbulentnosti v nizhnem 300 metrovom sloe atmosfery. Akademiya Nauk SSSR, Izvestiya, Seriya Geofizicheskaya n 5, 769-782.

Measurement of some turbulence characteristics in lower 300 m layer of atmosphere; layout of equipment used in measuring pulsations; results of measuring pulsation spectra of temperature and that of 2 wind velocity components, along with direct measurement of thermal turbulent flow spectra and friction stress; dependence is established of turbulent pulsations character on meteorological conditions. /EI/

345. Vaisala, Vilho, 1962: Principles of wind observations by means of the radiotheodolite. Vaisala News, No. 13, 3-11.

The theoretical basis of wind computation from a record obtained by means of the radiotheodolite, with particular reference to the periodicity of direction components, is presented. The equations for the coordinates of the radiosonde projection on the ground level and for determination of the period number by the two-frequency method and by the two-antenna set method are derived and examples of computations are presented.

346. Weather Bureau, 1959: Manual of wind-aloft observations (WBAN). U.S. Weather Bureau, Circular O, fifth edition. /R/

347. Weddleton, R. L., and E. E. Larrabee, 1959: Component development. Fifth Quarterly Report, Sept. 1 - Nov. 30, 1959, United Research, Inc. DA-36-039-SC-75064.

Reviews the concepts and background of wind shear measurement systems and demonstrates the new linear accelerometers now in

use. A brief discussion on the redesigned azimuth indicators and the Mylar-canopy-type electromechanical parachute recovery system is presented. The revised field test program that replaces the partially instrumented probe with the actual wind shear tests is demonstrated. The report announces a helicopter drop test scheduled for Jan. 1960. A discussion of the dynamic response expansion and detuned probe theory shows that the two correction factors which must be applied to probe data to yield the true wind shear which can be derived and applied independently. A probe telemetering system is demonstrated.

348. Weisner, A. G., 1956: Measurement of winds at elevations of 30 to 80 kilometers by the rocket-grenade experiment. J. Met., 13 (1), 30-39. [R]

349. Wescott, John W., 1964: Acoustic detection of high-altitude turbulence. Michigan Univ., Inst. of Science and Technology, 3746-38-T, 49 p. DA-20-018-ORD-22840, AD 434 705.

Background noise at frequencies from 0.2 to 200 cps was monitored with free-floating, balloon-borne acoustic probes at altitudes of 55,000 to 73,000 feet. Spectrograms, signatures, cross-correlations, and probability-density curves were obtained from the data. The noise has a spectrum with 6 db/octave negative slope, is acoustic and Gaussian, and is time-steady for periods of several hours, although noise pressures from 0.03 to 1 dyne/cm^2 were measured on different days. These and other results indicate that the noise comes from lower altitudes and is produced by an array of statistically independent radiators, such as turbulent eddies.

A theory for the power spectrum of noise radiated by turbulence is cited, and the predicted spectrum is compared to the experimental results. Other possible sources of the high-altitude acoustic noise are described. Descriptions and illustrations of the instruments used to acquire and process the experimental data are presented.

350. Whitaker, Clay, 1963: Recording theodolite. U.S. Army Electronic Proving Ground, AEPG ETA 81, 32 p. AD-406 635.

Tests were conducted to evaluate performance and operational accuracy of the recording theodolite to provide information on lower level winds and cloud ceilings when a balloon is assumed to have a known ascent rate, and to ascertain its suitability for field army use. Operation by one man, reduced operator training time, and elimintion of frequent source of recording errors, makes the recording theodolite more desirable than the present theodolite. It is concluded that the recording theodolite is suitable for field army use to record data when tracking meteorological balloons. It is recommended that the recording theodolite be considered for environmental testing and as a possible replacement for the present ML-474 theodolite system.

351. Wurtz, H. P., and R. S. Neiswander, 1963: Ground based mapping of upper air winds. Final Report, The Te Co., Report No. 3, 56 p. DA-36-039-SC-90685, AD 423 326.

This final report summarizes a study of the meteorological factors pertinent to the ozone layer and in particular bottomside observation of its thermal emission; the design, fabrication and laboratory checkout of a fixed field ozonosphere radiometer; and the test results of radiometric sky measurements. These experiments have established that, although apparently weak perturbations, structure does exist in the ozonosphere, and that this structure in the Santa Barbara area, is somewhat regular. If the structure is assumed to be persistent for periods longer than the observation time (10 minutes), these regularities could be interpreted as waves or "rollers" in the ozonosphere. All data in these tests was recorded as time varying measurements utilizing a fixed zenith field of view radiometer. The radiometer measured the difference between sky emission centered in the ozone band and the emission at the short wavelength wing of the band, thus balancing out "grey" effects of undetected clouds and water vapor. The observed ozonospheric time varying periodicity, with periods varying from 60 seconds to several hundred seconds, bear no direct correlation to upper atmosphere velocities, since it cannot be assumed that spatial wavelengths of the effect are invariant.

352. Zimmerman, S. P., 1964: Small-scale wind structure above 100 kilometers. J. Geophys. Res., 69 (4), 784-785,

By measuring directly altitude increment between inflection points of magnitude of wind velocity, as deduced from photographs of trail deformation, wavelengths or scale sizes of these small-scale perturbations may be determined without possible error introduced by superposition of correcting mean shear field; analysis was applied to sodium trail releases that covered altitude range of 80-160 km; data were separated into summer and winter components; viscous small-scale limitation and pressure scale height are superposed on data. /EI/

HUMIDITY SENSORS

See also: Bendix Corporation, 1962: Cricketsonde meteorological rocket and instrument package. (81)
Wenzel, R. F., 1964: Air-launched rocketsonde study. (173)

353. Army Artillery Board, 1961: Evaluation of radiosonde set AN/AMT-12. Report of Project No. FA 760.

The purpose of the evaluation of the radiosonde set, including a hypsometer sensor, was to determine its capability to measure more accurately at the higher altitudes. The material and its background is described and illustrated. Physical and operational characteristics and operational effectiveness were tested. Improvement in accuracy was found only in the region above 27 km. Details of test and findings are presented in the appendices.

354. Badinov, I. Ya., A. P. Gal'tsev, and G. A. Nikol'skiy, 1964: The spectroscopic method of integral determination of the water vapor content in a column of atmosphere. National Aeronautics and Space Administration, NASA TT F-212, 15 p.

This paper briefly discusses the spectroscopic measurement of atmospheric water vapor and reviews recent Western and Soviet instrumentation for measurements from the surface. Factors affecting the spectral absorption in addition to the amount of water vapor present include the temperature and pressure of the medium containing the water vapor, the presence of complexes of molecules, and changes in the spectral transparency of the atmosphere. The combined errors due to neglecting these effects is estimated at less than 4 to 5 percent for measurements in the wave band 0.94μ to 0.88μ. The design, theory of operation, and preliminary results from a small portable spectrometer for determining total water vapor content of an atmospheric column are presented.

355. Ballinger, J. G., L. Kirvida, M. P. Fricke, and J. E. Crowley, 1964: Alpha radiation hygrometer. Volume I: Automatic frost-point hygrometer for stratospheric water-vapor measurements. Final Report, May 1, 1961-July 15, 1964, Honeywell, Inc., AFCRL-64-690 (I), 95 p. AF 19(604)8418, AD-608 498.

This report describes a new type of automatic frost-point hygrometer for measurement of the atmospheric distribution of water vapor. The mass of the frost deposit on a cooled surface is detected directly by energy attenuation of alpha radiation. An automatic control maintains a constant amount of this frost by controlling the direction of current flow through a thermoelectric cooler. The instrumentation of this hygrometer is described in some detail, and balloon-flight tests of prototype units are presented.

356. Ballinger, J. G., M. P. Fricke, and R. D. Murphy, 1964: Alpha radiation hygrometer. Volume III: Current problems in stratospheric water-vapor measurements made with automatic frost-point hygrometers. Final Report, Jan. 1, 1963-July 15, 1964, Honeywell, Inc., AFCRL-64-690 (III), 32 p. AF 19(604)8418, AD-608 496. (See also: Crowley, John E. and Ahmet F. Konar, Volume II. (371))

Two basic problems inherent in the stratospheric application of all automatic frost-point hygrometers are examined. In particular, instrument inadequacy due to low rates of mass transfer is found to be a highly probable explanation of the current controversy about upper-atmosphere water-vapor content. The second problem is that of contamination of the moist-air sample by water vapor desorbed from the instrument package and vehicle. The magnitude of this effect precludes a simple accommodation of low mass transfer rates by use of long sampling times. Measures to increase the reliability of future stratospheric data are recommended.

357. Barrett, A. H., and V. K. Chung, 1962: Method for determination of high-altitude water-vapor abundance from ground-based microwave observations. J. Geophys. Res., 67 (11), 4259-4266.

Microwave resonance line at 22,235 Mc (lambda = 1.35 cm) arising from uncondensed H_2O in terrestrial atmosphere is examined in detail as means of providing easily obtained data on physical structure of atmosphere; line profile is drastically influenced by vertical distribution of H_2O and anomalous abundance of uncondensed H_2O above 15-20 km should be easily detected and monitored by ground-based passive microwave observations. / EI /

358. Barrett, Earl W., and Lee R. Herndon, Jr., 1951: An improved electronic dewpoint hygrometer. J. Met., 8 (1) 40-51. / R /

359. Barrett, Earl W., Robert L. Slater, and Kenneth E. Newton, 1955: Further improvements in the electronic dew-point hygrometer. J. Met., 12 (4), 308-313. / R /

360. Bendix Aviation Corporation, 1959: Final Report AN/AMQ-15 air weather reconnaissance system - dewpoint, Phase I, Supplement B, Report No. 1310. / R /

361. Bennett, L., and J. Stalder, 1964: Drop size sensor. Rev. Sci. Instr., 35 (1), 17-21.

A drop-size sensor capable of measuring the size and concentration of water droplets between 0.2 and 3 mm in diameter is described. Drops are transported in warm oil and forced over resistance measuring contacts. Individual drop size is determined by the time required for passage over the contacts. The sensor is intended for balloon-borne measurements and radio transmission of solid and liquid precipitation particle data. / PA /

362. Bologna, J. M., O. K. Larison, D. L. Randall, and D. L. Ringwalt, 1958: An airborne Lyman-α humidiometer. Naval Research Laboratory, NRL 5180. AD 201 906. / R /

363. Brasefield, C. J., 1954: Measurement of atmospheric humidity up to 35 kilometers. J. Met., 11 (5), 412-417. /R/

364. Brewer, A. W., B. Cwilong, and G. M. B. Dobson, 1948: Measurement of absolute humidity in extremely dry air. Proc. Phys. Soc. (London), 60, 52-70. /R/

365. Brown, J. A., Jr., 1960: Proposed water vapor instrumentation for use in the meteorological rocket. Presented at the American Rocket Society 15 Annual Meeting, Washington, D. C., December 5-8, 1960. 1470-60. /R/

366. Brown, J. A., Jr., and E. J. Pybus, 1964: Stratospheric water vapor soundings at McMurdo Sound, Antarctica: December 1960-February 1961. J. Atmospheric Sci., 21 (6), 597-602.

Data from eight water vapor soundings made with the dew-point hygrometer instrument at McMurdo Sound, Antarctica, are presented. These data are compared with various north temperate latitude data. The soundings are too spare to present a valid time cross section, but structure (layering) is evident on individual soundings. The mean Antarctic summer mixing ratio profile shows decreasing moisture to 4×10^{-6} gm/gm at the tropopause, then increasing to 1×10^{-4} gm/gm at 30 km. The Antarctic stratosphere appears to be as moist as the mid-latitude stratosphere, but both sets of data are influenced by an unknown amount of sample contamination.

367. Cambridge Systems, Inc., (1961?): Model 108 electronic dew point indicator. Cambridge Systems, Inc., Technical Bulletin (Preliminary). /R/

368. Cambridge Systems, Inc., 1963: Modification and testing of the Temperature-Humidity Measuring Set AN/TMQ-11(A). Final Report, Cambridge Systems, Inc., 67 p. AF 19(628)-410, AFCRL-63-595, AD-434 792.

This report discusses the engineering design and subsequent modification and testing of the surface Temperature-Humidity

Measuring Set AN/TMQ-11(A), which incorporates a thermoelectric dew point sensing system. All system components and modifications are described in detail. The results of extensive laboratory and field tests for three engineering test models are given. /STAR/

369. Cambridge Systems, Inc., 1964: Temperature/dew point set Model 110S. Cambridge Systems, Inc., Technical Data Bulletin 110B1, 11 p.

This system for continuous measurement of surface temperature and dew point consists of a remote transmitter containing aspirated temperature and dew point sensors and a control circuit containing the control amplifier and measuring bridge circuits.

The dew point sensor is a thermoelectrically cooled optically sensed dew point hygrometer compatible with the Air Force TMQ/11 and identified as Air Force Part ML-592/TMQ-11(A). The temperature sensor is a three wire platinum resistance thermometer.

Dew point range specified is -70°C to +30°C. Maximum dew point depression at 30°C ambient is to -17°C; at -40°C ambient, the minimum measurable frost point -73°C. Dew point accuracy is ±0.3°C for dew point above freezing, but decreases linearly to ±1.5°C at -73°C. Dew point response time is 2°C/sec tracking rate. The system requires 115 VAC, and there is no indication of adaptability to upper air soundings.

370. Charlson, Robert J., and J. J. K. Buettner, 1963: The investigation of some techniques for measurement of humidity at high altitudes. Scientific Report No. 1, Washington Univ., 21 p. AF 19(628)-303, AFCRL-63-415, AD-406 876.

Two approaches to the problem of measuring humidity at high altitudes are described. The first consists of the adaptation of the principle of gas chromatography to the separation of minute amounts of water from air. The laboratory experiments and apparatus are described. A possible design for an automatic chromatographic hygrometer is presented. The second approach consists of the use of the chromatographic packing as the dielectric of a small capacitor. The results of experiments with this new technique are presented. This device is unique inasmuch as its response can be described by an acceptable theory. The results of a literature survey are summarized. /STAR/

371. **Crowley, John E., and Ahmet F. Konar**, 1964: Alpha radiation hygrometer. Volume II: frost-point hygrometer for W-47 aircraft. Final Report, June 8-1962-July 15, 1964, Honeywell, Inc., AFCRL-64-690 (II), 95 p. AF 19(604)-8418, AD-608 503.

A frost-point hygrometer for use on W-47 aircraft has been designed utilizing alpha radiation techniques to measure the condensate thickness on cooled surfaces. A study of the problems associated with making frost-point measurements from high-speed aircraft was made as part of the design program.

372. **Cutting, C. L., A. C. Jason, and J. L. Wood**, 1955: A capacitance-resistance hygrometer, J. Sci. Instr., 32, 425-431. /R/

373. **Deam, A. P.**, 1959: An expendable atmospheric radio refractometer. Texas, Univ., Electrical Engineering Research Lab., Report No. 108. Nonr 375(08), AD 217 261. /R/

374. **Dodds, W. R.**, 1960: Signal Corps technical requirements, humidity element, automatic production and testing facility. Monmouth Electric Co., Inc. AD 234 996. /R/

375. **Dulk, George A.**, 1960: Development and flight test of a dew point hygrometer utilizing thermoelectric (Peltier) cooling. Ballistic Research Laboratories, Memorandum Report 1308.

A brief description of dew point hygrometer operation is given and Peltier effect theory is reviewed. Particular emphasis is placed on the construction of the instrument with the problems inherent in the utilization of thermoelectric materials. The flight test on a balloon is discussed and the test results presented and analyzed. Recommendations for future work are made.

376. **Dunmore, F. W.**, 1938: An electric hygrometer and its application to radio meteorography. J. Res. NBS, 20, 723-744. /R/

377. Elagina, L. G., 1962: Opticheskii pribor dlya izmereniya turbulentnykh pul'satsii vlazhnosti. Akademiya Nauk SSSR, Izvestiya, Seriya Geofizicheskaya n 8, 1100-1110.

Optical instrument for measurement of turbulent humidity pulsations; measurement of humidity pulsations according to absorptionof light by vapor in region of 1.38μ; calibration of apparatus and recording of humidity in near-surface layer of atmosphere. /Ei/

378. Elagina, L. G., 1963: Ob izmerenii chastotnykh spektrov pul'satsii absolyutnoi viazhnosti v prizemnom sloe atmosfery. Akademiya Nauk SSSR, Izvestiya, Seriya Geofizicheskaya n 12, 1859-1865.

Measurement of frequency pulsation spectra of absolute humidity in lower atmosphere; changes in absolute humidity were recorded by means of apparatus, principle of operation of which is based on light absorption by water vapor in region of 1.38μ; spectra of humidity pulsation in range of 0.01-1.5 cps were recorded when absolute humidity changed between 7 and 18 millibars. /EI/

380. Farrah, H. R., V. V. Vitale, and H. R. Young, 1962: Development of a dewpoint hygrometer for atmospheric sounding. Bendix Corp., Bendix RLD 2055, 110 p. AF 33(600)41821, AD 419 926.

This report describes the development of a thermoelectric-cooled, mirror-type dewpoint hygrometer for use in measuring dewpoint in the range of -80 C to +50 C in altitudes between 100 K feet and sea level. The hygrometer operates on the principle that when the water vapor pressure directly over a dew or frost film is in equilibrium with the partial pressure of water in the sample passing over a mirror surface, the temperature of the dew or frost film is the dewpoint temperature of the sample. Under equilibrium conditions, the dew or frost film on the mirror has a constant thickness. The hygrometer, by photodetecting the film thickness and thermoelectrically controlling the mirror temperature, maintains the film at a constant thickness. The mirror temperature under these conditions is at the required dewpoint temperature. This instrument can be adapted for balloonsonde or rocketsonde use. It is small, reliable, has simple sampling requirements, and shows promise of being produced economically. This report describes all the aspects of development, design and laboratory and environmental tests.

381. **Fateev**, N. P., 1958: Novy; avtomaticheski; kondensatsionnyi; gigrometr /New automatic condensation hygrometer/. Glavnaia Geofiziche-skaia Ovservatoriia, Trudy, No. 83, 3-19. /R/

382. **Foskett**, L. W., and N. B. Foster, 1943: A spectroscopic hygrometer. Bull. Am. Met. Soc., 24, 146-153. /R/

383. **Foster**, Norman B., David T. Volz, and Laurence W. Foskett, 1963: A spectral hygrometer for measuring total precipitable water. U.S. Weather Bureau, 26 p.

This paper describes a recording photoelectric spectral hygrometer developed by the U.S. Weather Bureau for determining the amount of water vapor in a vertical column of the atmosphere. Basically, the hygrometer monitors the relative radiant intensity of direct solar energy transmitted in a water vapor absorption band. A sensing path directed at the sun is maintained by means of a motor-driven equatorial mounting. The intensity of the radiation in the selected region of absorption is compared to that of a nearby region having essentially no absorption. The region of absorption is centered at 0.935μ and the reference region at 0.881μ. Narrow-band-pass interference filters isolate the two spectral regions. Silicon solar cells are used as radiation detectors. The instrument is designed so that the ratio of the photocurrents is proportional to the ratio of the transmitted radiant energies. Continuous ratio measurements are automatically obtained on a recording, self-balancing ratio bridge. Calibration depends on an empirical method involving simultaneous values of total precipitable water calculated from radiosonde observations. Both laboratory tests and trial operation have demonstrated the dependability of the spectral hygrometer. Its stable design makes it suitable for use in operational activities of meteorology as well as in research.

384. **Fraade**, D. J., 1962: Geräte zur Feuchtigkeitsmessung, Teil 1 /Instruments for moisture measurement, Pt. 1/. Zeitschrift für Instrumentenkunde, 70 (9), 1207-1212.

A review is given of different methods and instruments for moisture measurement. Dew point meters for observation or photoelectric determination of dew point, are described in Pt. 1, as well

as lithium chloride humidity meters. Other instruments treated in Pt. 1 are: hair hygrometer, instruments measuring the electrical conductivity changing with humidity, and thermal hygrometers. [MA]

385. Frazier, Q., 1958: Humidity element for vortex psychrometer. U.S. Army Signal Research and Development Lab., USASRDL TR-1987. AD 208 333. [R]

386. Glazova, E. F., 1960: Izmerenie vlazhnosti vozdukha termometrami soprotivleniia [Measurement of air humidity by resistance thermometers]. Glavnaia Geofizecheskaia Observatoriia, Trudy, 103, 90-92.

The author investigates the physical basis of the fact that wet bulb resistance thermometers give systematically higher readings than do the mercury psychrometric thermometers. The higher reading of the wetted resistance thermometer has been explained. The results of measurements of heat distribution along the length of the shielding cap showed an additional influx of heat to the surface of the cloth. Graphs are presented showing the distribution of temperature on the surface of the shielding cap of the resistance thermometer, the difference of temperature between the moistened thermometers and deviations of temperature, measured by a moistened resistance thermometer from temperatures measured with a moistened psychrometric thermometer. Resistance thermometers for measuring atmospheric humidity should have a protective vinyl plastic shield with a diameter not greater than 5 mm and a wall thickness not greater than 0.15 mm. The length of the thermometer placed within the shielding cap should not be greater than half of the length of the latter. A layer of heat insulation between the wire of the thermometer and the walls of the shielding cap is not effective. [MA]

387. Goldsmith, P., 1955: A method of increasing the range of the Dobson-Brewer frost-point hygrometer in jet aircraft. Quart. J. Roy. Met. Soc., 81 (350) 607-609. [R]

388. Gromov, A. M., 1960: An airplane condensation hygrometer with the automatic recording of dew point. Bulletin (Izvestiia) Academy of Sciences, USSR, Geophysics Series, No. 4, 620-625, English edition No. 4, 409-412. [R]

389. Grote, Heinz H., and Reinhold M. Marchgraber, 1963: The dynamic behavoir of the carbon humidity element ML-476. U. S. Army Signal Research and Development Lab., USAELRDL TR-2379, 28 p.

Measurements of the step-function response of carbon humidity element ML-476 taken at different environmental temperatures and with humidity steps of different magnitude are presented. The measurements were performed on a two-pressure system of high precision, with a test port modified to allow exposure of the elements under test to controlled humidity steps of negligible rise-time anywhere within the operating temperature range of the elements. The response characteristics obtained show a fast initial response followed by a slower drift to equilibrium. Mathematical models of second and third order for the response of the carbon element are given in a form yielding to the restoration of the input time function from the measured output of the humidity sensor. Though data restoration with this method is possible with a high degree of precision even with temperature-varying coefficients in the modeling differential equation, the obtainable accuracy is limited by the quality of the chosen model and especially by the "memory" feature of the carbon element, its hysteresis, and the consequent necessity for using a mean calibration curve in the evaluation of actual flight data.

390. Gutnick, M., 1961: Aids for computing stratospheric moisture. Air Force Cambridge Research Lab., GRD Research Notes No. 50. AFCRL 203. /R/

391. Gutnick, M., 1962: Mean annual mid-latitude moisture profiles to 31 km. Air Force Cambridge Research Lab., 30 p. AFCRL-62-681.

Average yearly vertical profiles up to 31 km for mid-latitudes, derived independently for mixing ratio and moisture dewpoint-frostpoint, are presented. Since the relation between mixing ratio and frostpoint is nonlinear, other moisture expressions were derived from each of the two basic profiles using Standard Atmosphere conditions. Up to 7 km the profiles were derived by an indirect approach, using conventional radiosonde humidity measurements. Above 7 km the profiles are based upon selected experimental humidity ascents, subjectively selected and weighted. The mixing ratio profile decreases from 6150 ppm at the surface to 9 ppm at 16 km, then increases slightly with height; the surface dewpoint is taken as 4°C, decreasing to -78°C at 18 km, then increasing to -71°C at 31 km.

392. Hanel, R. A., 1955: Design and development of an infrared-absorption hygrometer. Signal Corps Engineering Lab., Technical Memorandum M-1677. AD 66 812. /R/

393. Hanel, R. A., 1958: Design criteria for a sensitive infrared-absorption hygrometer. U.S. Army Signal Research and Development Lab., USASRDL TR-1988. AD 211 727. /R/

394. Hay, D. R., H. C. Martin, and H. E. Turner, 1961: Light-weight refractometer. Rev. Sci. Instr., 32 (6), 693-697. /R/

395. Hirshon, J. M., 1958: Final engineering report for phase I of study of investigation of electrical resistance humidity elements, June 1, 1957 to August 31, 1958. Philco Corporation. AF 33(616)-5224. /R/

396. Hirshon, J. M., 1959: Second quarterly engineering report for phase II of study and investigation of electrical resistance humidity elements, February 1, 1959 to April 30, 1959. Philco Corporation. AF 33(616)-5224. /R/

397. Houghton, J. T., T. S. Moss, and J. P. Chamberlain, 1958: An airborne infrared spectrometer. J. Sci. Instr., 35, 329-333. /R/

398. Houghton, J. T., and J. S. Seely, 1960: Spectroscopic observations of the water vapor content of the stratosphere. Quart. J. Roy. Met. Soc., 86, 358-370. /R/

399. Howell, Wallace E., 1961: A simple infra-red absorption meter for gauging precipitable water vapor. Bull. Am. Met. Soc., 42 (1), 17-19.

A simple absorption meter has been built, by using an interference filter, which compares the intensity of incident light in a water vapor absorption band and in a nearby "window" band. Experiments with the instrument show that it is sensitive to small differences in absorption not only from a direct sunbeam but also from diffuse light scattered by the sky or reflected from clouds. Further observations on clouds are suggested as perhaps being capable of useful interpretation. /MA/

400. Jones, Frank E., 1962: Evaporated-film electric hygrometer elements. J. Res. NBS, 66C (3), 209-216.

This paper reviews the development at the National Bureau of Standards of an evaporated thin film electric hygrometer element and presents experimental data to illustrate characteristics of the element. These characteristics are explained, at least in part, in terms of physical principles, and especially with reference to the physical adsorption process.

The applicability of the evaporated thin film to upper air humidity sounding is discussed. The effects of such variables as film thickness, substrate temperature, and heat treatment in the film production processes on the characteristics of the hygrometer element are illustrated. Of the fourteen compounds thus far investigated as the thin film material, results for barium fluoride, potassium metaphosphate, cerous fluoride, and lead iodide films are presented. Lead iodide films with electrodes deposited over the films are of particular interest due to the relative stability of the calibration with storage and the small temperature coefficient of electrical resistance. A plot of an upper air humidity sounding obtained with a barium fluoride element, indicating the rapid response and the high sensitivity of the element under flight conditions, is included.

401. Jones, Frank E., 1963: Performance of the barium fluoride film hygrometer element on radiosonde flights. J. of Geophys. Res., 68 (9), 2735-2751.

Ten balloon flights carrying the barium fluoride film hygrometer element in a modified radiosonde on the same train with a conventional lithium chloride element in an AN/AMT-11 radiosonde were made from the grounds of the National Bureau of Standards (Washington, D.C.) during the period Jan. 16 through July 21, 1961. The flights were intended to provide information on the performance of the barium fluoride element under conditions encountered in routine radiosonde flights, as well as information to be used in assessing the value of the element as a research tool. The results of the flights verified laboratory tests in several areas. The element responded to changes in humidity over a range of indicated relative humidity (RH) of 1.5 to 100% in the temperature range 33.1 to -58.7°C; preflight room temperature calibrations indicated that the 10 elements flown were typical, in this respect, of elements tested under laboratory conditions; expsoure to high humidity and passage through precipitation had no apparent effect on the functioning of the element; the rapid response of the element and its ability to resolve fine humidity structure were demonstrated; and indications of saturation or near-saturation were correlated with U. S. Weather Bureau surface observations of clouds and radar weather observations. In several of the flights, a strong correlation existed between changes in indicated RH and ambient temperature lapse rates. A sharp drop in indicated RH within the first several hundred feet above the surface in at least five of the flights was possibly related to boundary layer phenomena at or near the surface. In 2 of the flights the element indicated supersaturation with respect to ice. Although the instability with time of the barium fluoride element, in its present state of development, precludes its use in routine radiosonde flights, the 10 flights indicated the value of the element for experimental use. In addition to the flights carrying the barium fluoride element, 1 flight was made carrying a lead iodide film hygrometer element. /MA/

402. Jones, Frank E., and Arnold Wexler, 1958: Humidity characteristics of barium fluoride films. National Bureau of Standards, NBS-5897. /R/

403. Jones, Frank E., and Arnold Wexler, 1960: A barium fluoride film hygrometer element, J. Geophys. Res., 65 (7), 2087-2095. /R/

404. Kiseleva, M. S., B. S. Neporent, and V. A. Fursenkov, 1959: Spektral'noe opredelenie vlazhnosti vozdukha v verknikh sloiakh atmosfery /The spectral determination of water vapor in the upper atmosphere/. Optika i Spektroskopia, 6, 801-802, translation into English in Optics and Spectroscopy, 6, 522-524 (1959). /R/

405. Kiss, E., ed., 1961: Annotated bibliography on water vapor content of the atmosphere above 50,000 ft. Meteorological and Geoastrophysical Abstracts, 12 (8), 1668-1697. /R/

406. Kobayashi, H., 1963: Determination of dew-point by the use of a radioactive α-source. J. Appl. Phys. (Japan), 2 (9), 592-593.

A mixed α-source of Ra 'D', 'E' and 'F' was used. This may or may not be electroplated on the mirror surface of the dew-point hygrometer round which a suitable ionization chamber is built (diagram and description of the assembly is given). There is a sharp increase of ionization current when dew forms. This method is claimed to be free from the errors in methods where dew formation is observed visually or by photocell detection of dew scattered light. /PA/

407. Kobayashi, J., 1960: Investigations on hygrometry. Papers Met. Geophys. (Tokyo), 11 (2-4), 213-338. /R/

408. Latham, J., and C. D. Stow, 1964: A hygrometer for use at low temperatures. J. Sci. Instr., 41 (5), 324-326.

Measurement of the rate of mass change of a ventilated ice sphere enables the relative humidity in its environment to be determined. The sphere is suspended from a sensitive quartz spring and the vertical movements accompanying the mass changes are indicated, by means of an optical device, by pulses recorded on an electromagnetic counter. The instrument measures values of relative humidity correct to ± 5% over the temperature range 0 to -60°C. /PA/

409. Lee, Richard W. H., 1962: References pertaining to moisture sensing devices. National Acad. of Sciences-National Res. Council, PDL-43969, 6 p. AD 601 292.

A non-annotated, selected bibliography of 60 references.

410. Lenhard, Robert W., Jr., and B. D. Weiss, 1963: Error analysis of the modified humidity-temperature measuring set, AN/TMQ-11. Air Force Cambridge Research Labs., AFCRL Instrumentation for Geophysics and Astrophysics No. 28, 21 p. AFCRL-63-845, AD-416 341.

The results of tests performed at AFCRL to determine how closely the modified AN/TMQ-11 agrees with the ML-24 psychrometer are presented. The analysis is based on 2863 observations obtained under field conditions. All values were accepted as reported with no corrections in the recorded data. The AN/TMQ-11 responds to changes in dew point and temperature in the same manner as the ML-24. The tests indicate that a bias error exists in the AN/TMQ-11 dew-point sensors. If the bias of an individual dew-point sensor is determined and readings are adjusted compensate for this bias, dew-point temperature can be accepted as indicated or recorded.

411. Magee, J. B., and C. M. Crain, 1958: Recording microwave hygrometer. Rev. Sci. Instr., 29 (1), 51-54. / R /

412. Malkevich, M. S., Yu. B. Samsonov, and L. I. Koprova, 1963: Water vapour in the stratosphere. Soviet Physics-Uspekhi, 80 (1), 390-410.

The existing knowledge on the subject of stratospheric water vapour content is summarized under the following headings: Introduction; Local measurements of Humidity; Spectral Measurements; Indirect methods of measuring Humidity; Possible sources and sinks of moisture in the stratosphere: Conclusion. There are 49 references. / PA /

413. Marchgraber, R. M., 1959: Carbon-type humidity element, resistance ML-476/AMT. U.S. Army Signal Research and Development Lab., USASRDL TR-2052. / R /

414. Mastenbrook, H. J., and J. E. Dinger, 1960: Measurement of water-vapor distribution in the stratosphere. Naval Research Laboratory, NRL Report 5551. (See also: J. Geophys. Res., 66 (5), 1437-1444 (1961).) / R /

415. May, E. C., and A. B. Kahle, 1964: On the satellite determination of high-altitude water vapor. J. Geophys. Res., 69 (19), 4141-4143.

Studying high-altitude water vapor by means of satellite observation of the 1.35-cm water-vapor line profile appears unfeasible. The water-vapor density distributions now expected suggest that observations of this line will seldom, if ever, show large, easily discernible peaks. Since emission from the earth also greatly reduces the line profile as seen by a satellite, ground observations seem preferable.

416. McGavin, R. E., and B. R. Bean, 1961: A microwave hygrometer research study. National Bureau of Standards Report 6774. AD 263 913. /R/

417. McMurry, Earl W., 1962: Measurement of atmospheric water vapor by a spectrophotometric technique. Arizona Univ. Institute of Atmospheric Physics, Scientific Report No. 19, 15 p.

A spectroscopic technique was used to measure the total amount of water vapor between the point of observation and the Sun. Measurements were taken continuously throughout the day, yielding a detailed picture of water vapor variations as a function of time. Results from 28 days of observation over a period of a year show a wide variety of situations ranging from days of relatively stable and constant precipitable water vapor W to days in which large changes occur, sometimes quite abruptly. The median value of the range of W within successive 1-hr periods was found to be 0.05", with 10% of all ranges exceeding 0.12", the latter amounting to about 15% of the annual mean of W at the locality in question. It is concluded that significant W-fluctuations are commonly missed in routine radiosonde practice. Natural variations of W are, on the average, somewhat greater than the instrumental errors of radiosondes. Crude estimates of moist "bubble" diameters of 0.5 to 12 km were obtained. /MA/

418. Mester, J. C., 1960: Upper atmospheric research at the Ballistic Research Laboratories. IRE Trans. on Military Electronics, MIL-4, 222-227. /R/

419. Miller, L. E., 1953: The vertical distribution of water vapor in the stratosphere and upper atmosphere. Air Force Cambridge Research Center, Air Force Surveys in Geophysics No. 45, AFCRC TR 53-31, AD 25 115. /R/

420. Morris, Vernon B., Jr., and Frederick Sobel, 1954: Some experiments on the speed of response of the electrolytic hygrometer. Bull. Am. Met. Soc., 35 (5), 226-229. /R/

421. Murcray, David G., J. N. Brooks, Frank H. Murcray, and Walter J. Williams, 1960: Atmospheric absorption in the near infrared at high altitudes. J. Opt. Soc. of Am., 50, 107-112. (Also issued as Denver Univ. Dept. of Physics, Scientific Report No. 1, (1958). AF 19(604)-2069) /R/

422. Murcray, David G., J. N. Brooks, Frank H. Murcray, et al., 1960: Instrumentation for balloon-borne infrared spectral transmission measurements of the atmosphere. Scientific Report No. 3, Denver Univ. Dept. of Physics. AF 19(604)-2069, AD 236 976. /R/

423. Murcray, David G., F. H. Murcray, Walter J. Williams, et al., 1960: A study of the 1.4μ, 1.9μ, and 6.3μ water vapor bands at high altitudes. Scientific Report No. 4, Denver Univ. Dept. of Physics, AF 19(604)2069. (Also published in J. Opt. Soc. Am., 51, 186 (1961).) /R/

424. Murcray, David G., Frank H. Murcray, Walter J. Williams, and Frank E. Leslie, 1960: Water vapor distribution above 90,000 feet. J. Geophys. Res., 65 (11), 3641-3649.

The absorptions due to the $6.3\text{-}\mu$ band of water vapor were measured for altitudes up to 92,000 ft. On the basis of these absorptions the humidity mixing ratio for the region above 92,000 ft was calculated, the calculated values ranging from 1.5×10^{-4} g/g to 3.4×10^{-4} g/g. The mixing ratio from 40,000 to 92,000 ft was also calculated, yielding values at least an order of magnitude lower than the values obtained above 92,000 ft. It is concluded that at least 20μ of precipitable water was present above 92,000 ft over Alamogordo, New Mexico, on June 19, 1959.

425. Murcray, David G., Frank H. Murcray, and Walter J. Williams, 1961: Distribution of water vapor in the stratosphere as determined from infrared absorption measurements. Scientific Report No. 1, Denver Univ. Dept. of Physics. AF 19(604)-7429. /R/

426. Murcray, David G., Frank H. Murcray, and Walter J. Williams, 1962: Distribution of water vapor in the stratosphere as determined from infrared absorption measurements. J. Geophys. Res., 67 (2), 759-766.

The infrared solar spectrum from 1μ to 10μ was observed at various altitudes from the ground to 29 km over Alamogordo, New Mexico, on April 18, 1960. By studying the variation with altitude of the $6.3\text{-}\mu$ water vapor band and making certain assumptions concerning

the pressure dependence of the absorption, it has been possible to determine the distribution of water vapor with altitude up to 29 km. The method used is discussed in detail. The results are presented as an altitude profile of the mixing ratio and are found to be in good agreement with the results obtained by other investigators using different techniques. It is found that there were at least 11μ of precipitable water vapor present above 29 km over Alamogordo at the time of the flight.

427. Neporent, B. S., V. F. Belov, O. D. Dmitrievskii, G. A. Zaitsev, V. G. Kastrov, M. S. Kiseleva, L. A. Kudriavtseva, and I. V. Patalakhin, 1957: An experiment on the direct measurement of the variation in atmospheric humidity with height by a spectral method. Bulletin of the Academy of Sciences of the USSR, Geophysics Series No. 4, 163-167. /R/

428. Philco Corporation, 1962: Final engineering report on the design and testing of experimental development models of polyelectrolyte electrical resistance humidity elements and modifications and testing of radiosondes, AN/AMT-4. Philco Corporation, 60 p. AF 33(600)-42522.

The technical part of this report consists of six sections and six appendices. The section on the 14 flight tests contains tables of recorded data. The results of the studies reported in the other sections are presented in graphical (relative humidity vs. resistance) and tabular form and in chemical diagrams and charts. The report describes in detail the design considerations, fabrication procedures, measurements, and evaluation tests for the humidity elements. Measurements of response time show that the polyelectrolyte electrical resistance humidity elements are at least as good as carbon elements, and have the advantages of good response time, good sensitivity at low temperatures (such as -40°C), low hysteresis, and ability to be subjected to droplets of pure water with essentially no adverse effects.

429. Raab, Lars, 1954: The Finnish radiosonde with rolled hair as hygrometer. Tellus, 6 (4), 405-407. /R/

430. Randall, D. L., T. E. Hanley, and O. K. Larison, 1963: NRL Lyman-alpha humidiometer. Naval Research Laboratory, Progress Report, 1-13.

Microcells of moisture which scatter microwave signals in troposphere can be detected and measured almost instantaneously (1/20 to 1/100 sec) with airborne humidiometer, which is under development; instrument measures density of water vapor which selectively absorbs Lyman-alpha radiation of hydrogen (1216 Å) without disturbing air sample; arrangement is described; calibrations suggest that it may be equally useful for airborne measurements of humidity at dew point temperatures below freezing as well as above. /EI/

431. Rohrbough, S., 1963: Study of high altitude water vapor detectors. Scientific and Final Report, General Mills, Inc., 27 p. AF 19(628)-483, AFCRL-63-407. (See also: Steinberg, S., and S. Rohrbough, J. of Appl. Met., 1 (3), 418-421.)

This report describes the research and engineering required to prepare a sampling system for making water vapor and index of refraction measurements in the atmosphere. It covers the instrumentation, equipment testing, flight description, and results of the flight, and includes conclusions and recommendations. The purpose of the flight to 80,700 ft was to correlate data received from several different types of water-vapor indicators. These included four hygrometers (two alpha type and two optical type) and two gavimetric water vapor traps (the Dual Molecular Sieve unit and Goldsmith Vapor Trap). In addition, two microwave refractometers were flown to see if the two units functioned properly under operational conditions. Index of refraction data were obtained only from one unit; these followed published data for the first portion of the flight, but wandered radically during the latter half. The two alpha hygrometers functioned properly during ascent, but their data were erroneous because of contamination during float and descent. Their data are plotted in both graphical and tabular form. The Goldsmith Vapor Trap sampling was at a slower rate than expected but yielded a mixing ratio of 0.09±0.01 g per kg over an altitude range of 28 to 78 mb.

432. Ruskin, Robert E., ed., 1965: Humidity and Moisture: Measurement and Control in Science and Industry. Volume I: Principles and Methods of Measuring Humidity in Gases. Reinhold Pub. Corp., New York. 704 p.

. . . This volume is a collection of articles on the measurement of humidity in gases. It is based on the 1963 International Symposium on Humidity and Moisture held in Washington, D. C., and contains 68 articles. Topics discussed include new and standard techniques of psychrometry, dew-point hygrometry, electric hygrometry, spectroscopic hygrometry, and coulometric hygrometry.

433. Sargent, Jack, 1959: Recording microwave hygrometer. Rev. Sci. Instr., 30 (5), 348-355. /R/

434. Schotland, R. M., A. M. Nathan, E. A. Chermack, D. T. Chang, J. B. Neiger, and E. E. Uthe, 1962: Optical sounding. Technical Reports 1, 2, 3 and Final Report, New York Univ., DA-36-039-sc-87299.

Technical Report No. 2 under this contract is a preliminary analysis of three remote sounding techniques. Methods for the determination of the vertical distribution of water vapor, ozone and temperature are proposed and evaluated.

An active system for the determination of the vertical distribution of certain gases is analyzed. This system makes use of the spectral absorption characteristics of the energy scattered from an optical beam. A second active method is studied in which the temperature of the atmosphere is inferred from the Doppler broadening which occurs when a monochromatic beam of light is scattered by air molecules.

The final section of the report is concerned with the analysis of a passive radiometric sounding system for the determination of temperature profiles in the atmosphere. This technique is based on the angular dependence of energy received in a CO_2 absorption band.

Technical Report No. 3 describes experiments to test concepts developed in Technical Report No. 2 for the remote sounding of the atmosphere by optical methods.

In the first section an experiment is designed to measure the vertical profile of water vapor. This method is based on the differential absorption of infrared energy scattered from a searchlight beam.

An analysis is presented of a Doppler method for the determination of the temperature distribution in an arbitrary direction. This method is based upon the Doppler shift that occurs when monochromatic energy is scattered by air molecules under thermally induced motion.

A passive experimental technique for the determination of atmospheric temperature profiles has been analyzed. This method makes use of the variation of irradiance from a portion of the 4.3μ CO_2 band as seen by a detector scanning in elevation.

The Final Report of this contract presents two experiments that have been performed on problems related to passive atmospheric sounding. I. An experiment was performed at Acadia National Park during the total solar eclipse that occurred on July 20, 1963 in order to determine the relative contributions of solar scattering to the sky spectral radiance at 4.15 microns. It was found that the variation of spectral radiance that occurred during the period of 90 seconds past totality could be accounted for by variations in cloud emission and that scattering at this wavelength was negligible. II. A computer experiment was performed in order to test the sensitivity of the spectral sky radiance to a series of atmospheric thermal and moisture profiles. The spectral radiance was computed as a function of elevation scan angle and wavelength within the 4.3μ band of carbon dioxide. (See also: Schotland in General (53))

435. Schotland, R. M., E. A. Chermack, and D. T. Chang, 1963: Sounding of the atmosphere by indirect means, Pt. 6. Final Report, New York Univ., Cwb-10203.

This report describes the design, performance, and results of an experiment to measure the vertical humidity structure of the atmosphere by indirect means. The principle upon which this measurement is based involves the differential absorption of infrared energy (ρ-band) scattered from a searchlight beam. Experimental data taken at Brookhaven National Laboratory in summer 1952 are presented.

436. Schulze, W., 1952: Zur trägheit und feuchtemessung des gewalzten haares nach Frankenberger /On the lag and humidity measurements of rolled hair according to Frankenberger/. Ann. Meteor., 5, 35-45. Idem: Zur feuchtemessung in der freien atmosphäre mit dem gewalzten haar /Humidity measurement in the free atmosphere with rolled hair/, Ibid., 5, 223-226. /R/

437. **Sinha**, Evelyn, 1962: Bibliography on humidity measurement instruments. Meteorological and Geoastrophysical Abstracts, 13 (12), 3622-3717.

An annotated bibliography on humidity measurement instruments.

438. **Smith**, Walter J., and Nancy J. Hoeflich, 1954: The carbon film electric hygrometer element. Bull. Am. Met. Soc., 35 (2), 60-62. /R/

439. **Spencer-Gregory**, H., and E. Rourke, 1957: Hygrometry. Crosby Lockwood and Son, Ltd., London. /R/

440. **Steinberg**, Sheldon, and Rohrbough, Stephen F., 1962: Collection and measurement of carbon dioxide and water vapor in the upper atmosphere. J. Appl. Met., 1 (3), 418-421.

The authors describe a technique for collecting and determining quantitatively both the carbon dioxide and water vapor in the upper atmosphere. It works on the principle of adsorption of carbon dioxide and water vapor on synthetic zeolites. Sampling units with the zeolites are flown on balloons to an altitude of 30 km. "At altitude a blower draws ambient air at the rate of about 200 ft^3/min through two beds of synthetic zeolite. As the air passes through the beds, carbon dioxide and water vapor are adsorbed by the zeolite and the dry carbon dioxide-free air is then vented through a duct 50 ft below the unit." The basic sampling unit, the Dual Molecular Sieve Unit, and its operation are described with the aid of diagrams. The execution and results of an experimental flight are presented. The amounts of carbon dioxide recovered from each unit were in good experimental agreement with the theoretical percentage concentration of 0.031% and with each other. The observed ratio of Unit I (0.049gH_2O/kg air) was the same within experimental error as that given by other investigators. Unit II gave a greater (~3) collection of water vapor than Unit I. /MA/

441. **Stover**, C. M., 1961: Preliminary report on a new aluminum humidity element, UC-37. Sandia Corporation, SCTM-222A-60(52), previous edition (1960). /R/

442. Stover, C. M., 1961: AMT-4 radiosonde transmitter modification assembly (using the new aluminum-oxide humidity element), Technical Memorandum, UC-37 Instruments. Sandia Corporation, SCTM 151-61(72); Atomic Energy Commission, TID-4500 (16th Ed.). [R]

443. Stover, C. M., 1962: New aluminum oxide humidity element (second report), UC-37 Instruments. Sandia Corporation, SC-4667(RR); Atomic Energy Commission, TID-4500 (16th Ed.). [R]

444. Stover, C. M., 1963: Aluminum oxide humidity element for radiosonde weather measuring use. Rev. Sci. Instr., 34 (6), 632-635.

This article describes a new aluminum oxide humidity sensing element. The dlement was developed primarily for use in radiosonde weather measuring equipment. It has a fast response over the entire humidity range and through a broad temperature range of -80 to $+135^{\circ}F$. By using specially designed testers, measurements can be made which were previously unobtainable. The elements are small and lightweight, can be made inexpensively of readily available materials, and can be mass produced.

445. Suomi, V. E., and E. W. Barrett, 1952: An experimental radiosonde for the investigation of the distribution of water vapor in the stratosphere. Rev. Sci. Instr., 23 (6), 272-292. [R]

446. Underwood, C. R., and R. C. Houslip, 1955: The behavior of humidity-sensitive capacitors at room temperatures. J. Sci. Instr., 32, 432-436. [R]

447. Usol'tsev, V. A., 1959: Izmerenie vlazhnosti vozdukla (metody i pribory), [Measurement of atmospheric humidity: methods and instruments]. Gidromet, Izdat. [R]

448. Wexler, Arnold, 1949: Low-temperature performance of radiosonde electric hygrometer elements. J. Res. NBS, 43, 49-56. [R]

449. Wexler, Arnold, 1957: Electric hygrometers. National Bureau of Standards Circular 586. /R/

450. Wexler, Arnold, and W. G. Brombacher, 1951: Methods of measuring humidity and testing hygrometers. National Bureau of Standards Circular 512. /R/

451. Williamson, E. J., 1964: Balloon measurements of emission from the 6.3 microns water-vapour band. Mem. Soc. Roy. Sci. Liege, 9, 327-335. (Stellar Infrared Spectra: Twelfth International Astrophysics Colloquium, Liege, 24-26 June 1963.)

A balloon borne infrared radiometer is described. The instrument is designed to measure night emission from the 6.3μ water vapour band using a liquid air cooled gold doped germanium detector. Measurements at heights up to 20 km have been obtained. Interpretation of the data is discussed and the results used to calculate the vertical distribution of water vapour. /PA/

452. Wood, Rex C., 1958: Improved infrared absorption spectra hygrometer. Rev. Sci. Instr., 29 (1), 36-42. /R/

453. Wood, Rex C., 1959: The infrared hygrometer as a potential meteorological aid. Bull. Am. Met. Soc., 40 (6), 280-284. /R/

454. Wylie, R. G., 1957: A new absolute method of hygrometry. National Standards Laboratory, Division of Physics, Commonwealth Scientific and Industrial Research Organization, Commonwealth of Australia, PA-21. (Also: Nature, 175, 118 (January 15, 1955).) /R/

OZONE SENSORS

See also: Wurtz, H. P., and R. S. Neiswander, 1963: Ground based mapping of upper air winds. (351)

455. Armour Research Foundation, 1955: Quantitative determination of small amounts of ozone in atmospheres. Final Report No. 2 for American Petroleum Institute. [R]

456. Beltran, A. A., 1960: Atmospheric ozone, its detection, measurement, and effects, 1940 to 1959: an annotation bibliography. Lockheed Aircraft Corporation. [R]

457. Bendix Aviation Corporation, 1959: AN/AMQ-15 weather reconnaissance system. Final Technical Progress Report, August 15, 1958 to November 15, 1959, BSR-137. AF 33(600)-37984. [R]

458. Bendix Aviation Corporation, 1959: Final Report AN/AMQ-15 air weather reconnaissance system ozone, Phase 1. Report No. 1296. [R]

459. Bersin, R., F. J. Brousaides, D. Chleck, C. O. Hommel, and J. C. McCue, 1960: The study of inverse radioactive tracer techniques and applications of radioactive quinol clathrates. Second Annual Report, Tracerlab Inc., NYO 2764. AT(60-1)-2204. [R]

460. Bol'shakova, L. G., A. L. Osherovich, and I. V. Peisakhson, 1961: O sistematicheskikh oshibkakh pri fil'trovoi ozonometrii [Systematic errors in filtering ozonometry]. Atmosfernyi ozon, 65-71.

Systematic errors conditioned by the finite width of the spectral interval, cut by the filter in the photoelectric ozone meter with light filters, are discussed. It is shown that the error in determining the total amount of ozone in the atmosphere depends to a considerable extent, upon the half-width of the curve of the filter transparency, and photometry conditions. The half-width of the passing band should not exceed 100 Å, and the most advantageous zone for observation is the spectrum interval from 3100 Å to 3300 Å. [MA]

461. Bowen, I. Gerald, 1958: The measurement of atmospheric ozone. In Lovelace Foundation for Medical Education and Research, Aviation Medicine: Selected Reviews, 39-44.

Ozone has been considered a possible; though unproven, toxicological threat to aviation personnel. Method of measuring ozone concentrations present at various altitudes is described. Ozone concentration was plotted using partial pressure as a function of altitude. Employing the above data, partial pressure of ozone which might affect a lung was computed on the "wet" basis as a function of cabin pressure and altitude. These data, combined with those setting forth the limits for ozone concentration allowable in industry, indicated a potentially dangerous situation. However, the rather wide discrepancies in medical literature relevant to toxic concentrations of ozone, along with the instability of the gas, particularly at high temperature, did not confirm the opinion regarding the existence of a danger. The author suggests actual determination of ozone concentrations in the cabins of pressurized and nonpressurized high-flying aircraft as an initial step in proving or disproving the hypothesis.

462. Bowen, I. Gerald, and Victor H. Regener, 1950: On the automatic chemical determination of atmospheric ozone. In Investigation in the physics of atmospheric ozone, New Mexico Univ. Report No. 12 (final, October 1, 1950 to November 30, 1950, p 10. (See also: Bowen and Regener. J. Geophys. Res., 56, 307-324 (1951).) / R /

463. Brewer, A. W., and J. R. Milford, 1960: The Oxford-Kew ozone sonde. Proc. Roy. Soc., 256, 470-495. / R /

464. Britaev, A. S., 1961: K voprosu ob opredelenii soderzhaniia ozona khimicheskim metodom / Problem of the measurement of ozone content by a chemical method /. Atmosfernyi ozon, 18-31.

The ozone group of the Central Aerological Observatory has designed a chemical ozone measuring apparatus. The electrochemical method makes it possible to observe the oxidation by ozone of the KJ-solution in water or in various buffer solutions, the conductivity of solution (alternate current of 1600-1000 cycles per sec) remains constant after all KJ is oxidized. In this manner the ozone content of air near the ground was measured. Our observations have demonstrated that the concentration near the ground follows, generally speaking, the variations of total ozone content, increasing with the N and NW winds, etc. Some exceptions of this rule make possible the existence of sources of O_3 near the ground. Diurnal range of ozone is marked by the broad maximum in the midday hours and minimum at night. / MA /

465. Dave, J. V., P. A. Sheppard, and C. D. Walshaw, 1962: The vertical distribution of atmospheric ozone by methods of infrared spectrography and related problem of the atmospheric continuum. Technical Report, Imperial College of Science and Technology, Meteorology Dept., 78 p. AF 61(052)-84.

The analysis of high resolution sky emission measurements in the 9.6 μ ozone band at six different air masses taken at Ascot, England for 5 standard frequencies in the region 900-1200 cm^{-1} using a slit-width of 2.5 cm^{-1} brings out the following points regarding the atmospheric continuum and the vertical distribution of ozone. 1. The continuum absorption coefficient is increased by a factor up to 2.5 due to the presence of aerosol in the atmosphere and that this factor is different for different frequencies. 2. Systematic errors of ozone content of uncertain magnitude, but positive in the lower troposphere, are introduced by the use of an ozone transmission function based on low resolution measurements. 3. The computed ozone contents of the 600-300 mb and 300-100 mb layers depend upon the assumptions made about the distribution of ozone within the layers. 4. Even with all these drawbacks, the relative variations of ozone content in the surface-600 mb layer can be determined with 10% accuracy which is acceptable for the study of diurnal changes. Although the present study has exposed unacceptable weaknesses in the high resolution technique as used, particularly in regard to ozone contents in the upper troposphere and lower stratosphere, we consider that our study strongly suggests scope for the technique in the relatively dry and haze-free atmosphere above many hill stations. The problem of the ozone transmission function appropriate to the slit-width used clearly needs attention first. It might well then turn out that the restriction to dry, haze-free atmospheres becomes unnecessary. A radiosonde for temperature and humidity at the place and time of observation is clearly desirable and a direct comparison with a chemical ozone sonde would be advantageous. /MA/

466. Dobson, G. M. B., 1963: Note on the measurement of ozone in the atmosphere. Quart. J. Roy. Met. Soc., 89, 409-411.

The absorption coefficients of ozone for ultra-violet wavelengths which have previously been accepted as correct, do not agree with measurements made on the ozone in the atmosphere. New laboratory measurements are now reported, in which the same spectroscopic apparatus is employed as is used in the atmospheric work. The absorption coefficients so found agree well with the atmospheric values. The possibility that there may be other gases in the atmosphere, in addition to ozone, which absorb in the ultra-violet region is examined. Only sulphur dioxide might possibly give trouble but the amount present is too small to cause appreciable errors in the ozone measurements. / PA /

467. Ehmert, A., 1952: Simultaneous measurements of the ozone content of air near the earth at several stations by means of a simple absolute method. J. Atmospheric and Terrest. Phys., 2, 189-195. / R /

468. Epstein, Edward S., Charles Osterberg, and Arthur Adel, 1956: A new method for the determination of the vertical distribution of ozone from a ground station. J. Met., 13 (4), 319-334. / R /

469. Epstein, Edward S., and Arthur Adel, 1959: Vertical ozone distributions from absorption and radiation by ozone. Advances in Chemistry Series, 21, 221-225. (Also: In International Ozone Conference, Chicago, Nov. 1956, Ozone Chemistry and Technology, Proceedings, 221-225.)

The fundamental innovation of the VODARO technique (vertical ozone distributions from absorption and radiation by ozone) is application of infrared observations to determine the vertical distribution of ozone. As with most new developments, the initial discovery must be followed by a period of modifications and testing before anything like perfection and wide usage can be expected. This is a summary of one year's data applied to computations of temperature changes in the stratosphere.

470. Frith, R., 1962: Ozone in the earth's atmosphere. Contemporary Physics, 3, 375-381.

O_3 accounts for no more than 1 part in 10 million of the earth's atmosphere, but, nevertheless, plays an important part in cutting off the plant damaging radiation from the surface of the earth. The absorption by O_3 of radiation above 2900 Å was first recognized following work by Hartley on the absorption spectrum of O_3 in 1880. Instrumental techniques for the measurement of O_3 are based, in the main, on the Dobson ozone spectrometer. Global use of this instrument at the earth's surface has made possible studies of the global distribution of the total atmospheric content and its variations with time. Latitudinal variations and variation with surface synoptic structures can be traced. In 1934 new instruments making use of photo-electric cells made it possible to use scattered light to measure the O_3 content and this enabled estimates to be made of the height distribution of O_3. At about the same time the theory of the formation of O_3 by the action of ultraviolet radiation with O_2 was being developed. Above 40 km the ultraviolet radiations are such that equilibrium states are reached quickly, that at these heights air movements have little effect on its distribution. At lower heights, however, it is unlikely that equilibrium states are ever reached and the O_3 distribution will depend to a great extent on air movements. It is hoped that the satellite measurements of O_3 distribution shortly to be made will yield information on air movements at heights down to 30 km. In these experiments measurements will be made at sunrise and sunset and the vertical structure of the O_3 content determined. Below 30 km optical and chemical methods of measuring O_3 concentrations from balloon-borne equipment will be applied.

471. Gergen, J. L., 1961: Ozone. In Summary Report, 1959 and 1960, Atmospheric Physics Program, Minnesota Univ., p. 39. Nonr-710(22). [R]

472. Glaser, A. H., F. E. Hatch, and W. Stevens, jr., 1960: An evaluation of ozonesondes. Final Report, Allied Research Associates, Inc. AF 19(604)-3493, AD 236 722. [R]

473. Götz, F. W. P., 1951: Ozone in the atmosphere. In Compendium of Meteorology, T. F. Malone, ed., American Meteorological Society, 275-291. [R]

474. Gushchin, G ., 1961: Metod rascheta obshchego soderzhaniia atmosfernogo ozona dlia priborov so svetofil'trami [Method for computing the total atmospheric ozone content for instruments with light filters]. Atmosfernyi ozon, 141-148.

A method is developed for measuring the total amount and vertical distribution of atmospheric ozone by instruments with wide bands of transmittance in the ultraviolet part of spectrum. The system of computation of ozone content after observational data is considerably simplified. [MA]

475. Gushchin, G. P., 1961: O dvukh vazhnykh osobennostiakh ozonometricheskikh priborov [Two important peculiarities of ozone meters]. Atmosfernyi ozon, 176-183.

Two factors are considered that influence essentially the measured quantity of ozone, i.e., the solid angle of the ozone meter and the temperature of the ozone meter. [MA]

476. Hering, Wayne S., and Robert F. Myers, 1962: Detailed structure of the vertical ozone distribution over Bedford, Mass. McGill Univ., Arctic Meteorology Research Group, Pub. in Met. No. 47, 67-70.

Performance characteristics of Regener's chemiluminescent ozonesonde were examined in a series of experimental ascents at Bedford, Massachusetts. Regener's ozonesonde is a dry chemical instrument for measuring the energy released as a result of luminescent reaction between atmospheric ozone and sensitized disc treated with an organic dye, rhodamine(B). Air is aspirated past the disc at a constant flow rate yielding instantaneous and direct quantitative measurement of ozone density. Sample soundings and vertical ozone distribution are shown on a chart and mean and standard deviation of ozone mixing ratio in troposphere-- in a table.

477. Hersch, P., and R. Deuringer, 1963: Galvanic monitoring of ozone in air. Analytical Chem. 35 (7), 897-899.

Study pertaining to meteorology, air pollution and industrial hygiene; method for monitoring ozone in air down to air pollution concentrations uses galvanic cell with platinum cathode, carbon anode, and neutral buffered solution of halide as electrolyte; no external emf is applied; there is no need for calibration and standardized source of ozone. [EI]

478. Hirshon, J. M., 1958: A detection system for ozone employing polyelectrolyte films. Philco Corp., WADC TR 58-50. AD 155 667. [R]

79. Hommel, C. O., D. Chleck, and F. J. Brousaides, 1961: Ozone analyzer uses radioactive clathrate. Nucleonics, 19, 94-102. /R/

80. Hunt, B. G., 1961: A review of the published literature on the ozonosphere. Weapons Research Establishment (Australia), SAD-79, 44 p.

This review attempts to summarize the salient points made in the very extensive literature which exists on ozone in the atmosphere. Methods of measurement, variations of atmospheric ozone, temperature variations of the ozone layer, theories of the formation of ozone, and the influence of ozone on the radiation balance of the earth are discussed. /STAR/

81. Iakovleva, A. V., et al., 1962: Spektrometricheskoe issledovanie ozonnogo sloia do vysoty 60 km /Spectrometric investigation of the ozone layer up to an altitude of 60 km/. Iskusstvennye Sputniki Zemli, No. 14, 57-68.

Self-recording rocket-borne spectrographs measured ozone concentrations at high altitudes up to the highest ozone layer from the intensity of absorption of solar ultraviolet radiation. The comparison of results of direct rocket-borne measurements with computation from observations of scattered zenithal light gave satisfactory agreement. However, American computational data showed a higher altitude of the gravity center of the ozone layer, than that obtained by direct measurements. The exponential decay of ozone at an altitude of 35 to 55 km, established by direct measurements, indicates an important distribution law in the upper ozone layers. /MA/

82. International Union of Geodesy and Geophysics, 1960: Symposium on atmospheric ozone. Imprime Par L'Institut Geographique National, Monographie No. 3. /R/

83. Iozenas, V. A., and A. P. Kuznetsov, 1961: Fotoelektricheskii spektrofometr dlia nabliudeniia za atmosfernym ozonom /Photoelectric spectrophotometer for the observation of atmospheric ozone/. Atmosfernyi ozon, 14-17.

For the observation of atmospheric ozone, a spectrophotometer was constructed in the Moscow Univ. on the basis of the double quartz monochromator. Minimal registered flux in the region 3100 Å was 10^{-14} w/cm^2 sec. This spectrophotometer gives a possibility to measure ratios of intensity for several pairs of wavelengths in solar spectra during the day, 10 min before sunrise and 10 min after sunset. /MA/

484. Johnson, F. S., J. D. Purcell, and R. Tousey, 1951: Measurements of the vertical distribution of atmospheric ozone from rockets. J. Geophys. Res., 56, 583-594. /R/

485. Johnson, F. S., J. D. Purcell, R. Tousey, and K. Watanabe, 1952: Direct measurements of the vertical distribution of atmospheric ozone to 70 kilometers altitude. J. Geophys. Res., 57, 157-176. /R/

486. Kaplan, Lewis D., 1960: Spectroscope as a tool for atmospheric sounding by satellites. Instrument Society of America, Preprint No. 9-NY60, 6 p. Paper presented at its Fall Instrument-Automation Conference and Exhibit, N. Y. City, Sept. 26-30, 1960. Also issued as Massachusetts Institute of Technology, Technical Report No. 5, (Atmospheric Radiation Project), N-ONR-1841(45).

A previous suggestion by the author that the atmosphere can be sounded by remote satellite measurements of thermal radiation is discussed in more detail. Preliminary calculations show that the accuracy required to determine the temperature structure to within a degree or two is probably obtainable for fairly large atmospheric layers. Singer's method of satellite ozone soundings is shown to be an extremely sensitive technique for determining the upper level ozone distribution in considerable detail. /MA/

487. Kaplan, Lewis D., 1961: On the determination of upper-atmosphere composition from satellite measurements. In International Symposium on Chemical Reactions in the Lower and Upper Atmosphere, San Francisco, Calif., April 1961, Proceedings. N. Y., Interscience Pub., 269-274.

The spectrum of scattered solar ultraviolet radiation, as measured from outside an atmosphere, can be interpreted in terms of vertical distribution of absorbing gases. A method is first discussed in general, then applied to the problem of determination of ozone distribution in the upper atmosphere. Instrumental requirements are discussed. /MA/

488. Khvostikov, I. A., 1963: Fizika ozonosfery i ionosfery /Physics of the ozonosphere and the ionosphere/. Akademiia Nauk SSSR. Mezhduvedomstvennyi Geofizicheskii Komitet, Resul'taty Issledovaniia V Razdel Programmy MGG (Ionosfernye Issledovaniia), No. 11, 662 p.

An impressive monograph giving a thorough survey of the results of the IGY investigations in the Soviet Union and elsewhere, combined with previous and more recent results as reported in over 1500 scientific papers (354 Soviet and 1163 from other sources). The volume consists of 2 books -- Book One deals with ozonosphere methods, results of measurements of ozone content, vertical distribution, eclipse measurements by Umkehr method, rocket studies, theory of origin of ozone layer, and theoretical calculations of vertical distribution of ozone. Pt. II takes up oxygen dissociation, atomic nitrogen and nitrogen oxide in the upper atmosphere. Pt. III the atmosphere and geomagnetic phenomenon; Pt. IV the airglow, night glow, twilight airglow and dayglow; Pt. V the theory of magnetic disturbances and airflow, aurora, etc., and artificial aurora. Book Two takes up thermal conditions of the ozonosphere and ionosphere: Pt. I deals with acoustic, optical, ionospheric, rocket and satellite temperature measurements, and atmospheric tides; Pt. II, thermal processes in upper atmosphere and thermosphere. /MA/

489. Kudriavtseva, L. A., 1961: Rezul'taty izmerenii vertikal'nogo raspredeleniia atmosfernogo ozona na rakete /Results of rocket measurements of the vertical distribution of atmospheric ozone/. Atmosfernyi ozon, 6-13.

On Oct. 1, 1958, an ultraviolet spectrograph was sent up in a rocket to determine the vertical zone distribution. The instrument was provided with automatic exposure exchange and with a tracer system for continuous aiming at the sun. Owing to certain defects, spectra were obtained only up to an altitude of 24 km. The data were treated after the scheme described in (1) with slight modifications, which made it possible to calculate the ozone concentration without assuming exact equality of the exposure time at different heights and without knowing the extra atmospheric intensity of solar radiation. A distribution curve was obtained having a single maximum from 21 to 23 km, where the concentration amounted to $(17.5 \pm 0.6)\ 10^{-3}$ cm per km, using the Vigroux absorption factors. The total ozone content in the 0 to 24 km layer was found to be rather high for the autumn season (0.19 cm), which was probably connected with the weather conditions (intrusion of cold air). /MA/

490. Kulcke, Werner, and Hans K. Paetzold, 1957: Über eine radiosonde zur bestimmung der vertikalen ozonverteilung /A radiosonde for determining the vertical distribution of ozone/. Ann. Met., 8 (1/2), 47-53. /R/

491. Kuznetsov, A. P., A. S. Britaev, and V. A. Iozenas, 1961: Nabliudeniia nad vertikal'nym raspredeleniem ozona v atmosfere /Observations of the vertical ozone distribution in the atmosphere/. In Konferentsiia po Itogam MGG (1960) i Meteorologicheskogo Izucheniia Antarktidy (1959). Materialy Konferentsii, 179-182.

For the study of ozone content in the atmosphere, an indirect method was used, which determines effects of direct and dispensed ultraviolet light of the sun weakened by the ozone concentration in the lower atmosphere. The method employs relative measurements of intensity of ultraviolet dispersed light on two wave lengths: one of which absorbs ozone considerably and another -- very slightly, at different solar zenith distances. This method is described with numerical example and graphic illustration of ozone distribution of different altitudes in the region of the lower Volga River Basin. /MA/

492. Kuznetsov, G. I., 1962: O metodike rascheta vertikal'nogo raspredeleniia ozona v atmosfere /Method of calculating vertical ozone distribution in the atmosphere/. Geomagnetizm i Aeronomiia, 2 (2), 305-312.

Utilization of observations of direct solar radiation in the ultraviolet end of the spectrum in evaluating the average height of the ozone layer was proposed a long time ago by Fabria and Buisson. The mathematical basis for this was given by Ambartsumian (1934). In this paper the author presents a practical method for determining the vertical distribution of ozone and the basic characteristics of the

layer (particularly the height of its center of gravity) from observations of the ultraviolet part of direct sunlight. The center of gravity of the ozone layer in the Lower Volga region in the summer of 1957 computed by this method was 24-26 km. This value and the negative correlation of total ozone with the heights of its center of gravity found by the author confirm the results reported by Epstein and Adel (1958) whose curve covering a range from 9°N to 77°N is shown. The author's lower value for the Lower Volga falls on this curve. [MA]

493. Liege Univ., Institut d'Astrophysique, 1963: Studies of atmospheric ozone, infrared radiation and atmospheric transmission. Final Report, 15 July 1956-31 May 1963, Liege Univ., Institut d'Astrophysique. AF 61(514)-962.

494. Mast, G. M., and H. E. Saunders: Research and development on the instrumentation of ozone sensing. (Apparently published by Mast Development Co., Davenport, Iowa). [R]

495. Mateer, C. L., 1964: A study of the information content of Umkehr observations. Technical Report No. 2, Michigan Univ., 199 p. NSF G-19131.

496. Mattana, N., 1963: Direct spectroscopic measurement of the concentration of ozone in the atmosphere. Ann. Geofis., 16 (3), 423-428.

A brief report, presented during the session "Optics and Spectroscopy of the upper atmosphere" of the second International Technical Scientific Meeting on Space (Rome, 1962), concerning some spectroscopic systems for direct measurement of atmospheric ozone. [PA]

497. Mayfield, E. B., et al., 1963: Experiment and preliminary results of satellite determinations of the vertical distribution of ozone and of the albedo in the near ultraviolet. Aerospace Corporation, TDR-169(3260-50)TN-2, 40 p. AF 04(695)-169.

498. McCully, C. R., J. F. Roesler, E. S. Gordon, J. N. Van Scoyoc, and R. A. Carrigan, 1961: An instrument for continuous analyses of atmospheric ozone. IRE Trans. on Instr., I-10, 89-93. [R]

499. Moscow, University of, 1961: Atmosfernyi ozon: rezul'taty rabot Mezhdunarodnogo geofizicheskogo goda v SSSR konferentsiia 28-31 oktiabria 1959 goda: doklady i rezoliutsii /Atmospheric ozone: Results of work under the IGY in the USSR, Conference of Oct. 28-31, 1959: papers and resolutions/. (For listing of contents, articles abstracted separately, see Met. Abs., 13 (5), 1450, May 1962.)

A handy book comprising 20 papers on various aspects of atmospheric ozone investigations made during IGY and presented at the Conference on U.S.S.R. IGY Ozone Results held in Moscow on Oct. 28-31, 1959 by the Hydrometeorological Service and the Akademiia Nauk SSSR with several other institutions participating. The introduction by Khrgian gives details of organization of the Conference, and plans for future ones. The 18 scientific papers, each of which has an English abstract, are concerned with the vertical distribution, total content, errors in measurement, types of instruments, relations with atmospheric circulation, sources, temperature effects, seasonal, geographical, and meteorological variations, diurnal variations, comparisons of instruments, etc. Among the participants and contributors were: A. Kh. Khrgian, E.S. Kuznetsov, A.P. Kuznetsov, G.I. Kuznetsov, and V.A. Iozenas of Moscow State Univ.; S.F. Rodionov, and A.L. Osherovich of Leningrad Univ.; G.P. Gushchin, A.A. Znaminskii, R.G. Romanova, K.L. Romashkina, and B.E. Shneerov of the Glav. Geofiz. Obs.; A.S. Britaev, L.A. Kudriavtseva and V.D. Reshetov of the Central Aerol. Obs.; R.G. Karimova of Arctic Inst.; T.S. Gol'm of the Dickson Is. Obs.; Sh. M. Chkhaidze of the Abastumani Astrophys. Obs. and others. Considerable data are presented in selected and analyzed form and there are numerous sketches, photos, graphs, charts, tables, curves and much theoretical presentation. Resolutions of the Conference complete the volume. /MA/

500. Murray, W. D., and H. K. Work, 1953: Ozone sonde development. Final Technical Report 140.08, New York Univ. AF 19(122)-238, AD 16 879. /R/

501. Murray, W. D., and H. K. Work, 1953: Ozonesonde evaluation. Final Technical Report 263.02, New York Univ. AF 19(604)-763, AD 28 281. /R/

502. Ney, E. P., and J. L. Kroening, 1961: Atmospheric ozone. Minnesota Univ., Technical Report No. AP-13, Atmospheric Physics Program. Nonr-710(22). /R/

503. Osherovich, A. L., and S. F. Rodionov, 1961: O nekotorykh tipakh fotoelektricheskikh ozonometrov /Some types of photoelectric ozone meters/. Atmosfernyi ozon, 72-81.

Two types of photoelectric ozone meters are described. In the first device - for the purpose of separation of comparatively narrow zones of the spectrum in the range of 3100-3300 Å and, in some cases, 4000-4500 Å - interference light filters with a dielectric coating are used. A differential cathode repeater with a low zero drift is used in the device for increasing the photoelectric current. The second device, of the observatory type, with a high spectrum resolution (the linear dispersion at 3100 Å being 12.3 Å/mm), great sensitivity and low inertia of the system consists of the following units: 1) an automatically guiding coelostat, 2) a double monochromator with diffraction gratings and fixed slits for separating three zones of the spectrum (3100, 3300 and 4358 Å), 3) an electrophotometer with recorder. /MA/

504. Paetzold, Hans-Karl, 1961: Research on the synoptical measurements of the vertical ozone distribution. Cologne Univ., Technical Note No. 1, AF 61(052)-330, AD 273 182. /R/

505. Paetzold, Hans-Karl, 1961: Messungen des atmosphärischen Ozons /Measurements of atmospheric ozone/. Handbuch der Aerologie, Walter Hesse, ed., 458-531.

. . . A systematic survey of atmospheric ozone measurement techniques: history since 1858, importance of ozone, variations (diurnal, seasonal, lat., air mass, year-to-year and vertical); absorption spectrum of ozone in Hartley, Huggins, Chappius and Infrared bands; optical measurements (UV, total, vertical); umkehr measurements; ozone soundings with UV spectrographs and ozone radiosondes of several types (Coblentz and Stair; Paetzold and Kulcke; Vassy) chemical ozone measurements: theory or basis, V.H. Regener's and Brewer's chemical ozonesonde; comparison of the various methods and their efficiency. A large number of charts, records, graphs, tables, etc. illustrate methods and equipment used, and data obtained from soundings. The author's own system is outlined in great detail and with many schematic and line drawings.

506. Pittock, A. B., 1963: Determinations of the vertical distribution of ozone by twilight balloon photometry. J. Geophys. Res., 68 (18), 5143-5155.

Further details are given of a method of determining the vertical distribution of ozone by photometry of a balloon at twilight. The theory and apparatus are discussed, and some results are presented. The principle is analogous to the lunar eclipse method, and, apart from some differences in theoretical treatment of the data, it is similar to that applied elsewhere to observations of the Echo 1 satellite. The results, for the southern spring of 1962, show two maxima, one in the 10 to 15 km layer and the other in the 20 to 25 km layer. / PA /

507. Pittock, A. B., and J. G. Sparrow, 1961: Summary of methods of determining the vertical distribution of ozone. Australian Met. Mag., 37-55.

Brief descriptions are given of the various direct and indirect methods of determining the vertical distribution of atmospheric ozone, using its chemical or optical properties. Some attempt has been made to evaluate these methods in terms of accuracy and applicability. Numerous references (eighty-two) are given, as well as an indication of the three lines of research in this field currently being pursued by the authors.

508. Rasool, I., and A. Vassy, 1956: Remarques sur les methodes chimiques de dosage de l'ozone atmospherique / Remarks on the methods of chemical sampling of atmospheric ozone /. Compt. Rend., Acad. Sci. Paris, 243, 298-299. / R /

509. Rawcliff, R. D., G. E. Meloy, R. M. Friedman, and E. H. Rogers, 1963: Measurement of vertical distribution of ozone from a polar orbiting satellite. Aerospace Corporation, SSD-TDR-63-161, 18 p. AF 04(695)-169, AD-413 857. (See also: J. Geophys. Res., 68 (24), 6425-6429 (1963).)

A satellite-borne radiometer has been used to determine the vertical distribution of ozone at high altitudes. The attenuation, due to the ozone, of solar ultraviolet radiation passing obliquely through the atmosphere was measured at times of sunrise and sunset (as seen by the orbiting vehicle). The sensor employed a photomultiplier tube and filter combination plus a quartz light pipe that allowed a uniformly sensitive field of view of ±10 deg in elevation and 360 deg in azimuth. A transition from full sunlight to a signal extinction, or vice versa, occurred in a period of about 20 seconds, twice per orbit. The shape of this step has been analyzed with a 7090 computer program to deduce the vertical ozone distribution at altitudes above the maximum. The orbital parameters were such that sunset and sunrise occurred when the vehicle was near 33°S and 13°S latitudes, respectively. Preliminary results are essentially in agreement with earlier rocket measurements of Johnson, et al.; they do not indicate a secondary high altitude maximum as reported by Venkateswaran, et al.

510. Reed, Edith, and Reuben Scolnik, 1964: A night-time measurement of ozone above 40 km. National Aeronautics and Space Administration, X-613-64-267.

The ozone distribution between 40 and 70 km was measured near midnight, May 27, 1960, from Wallops Island, Virginia by means of photometers sensitive to the ultraviolet airglow at wavelengths between 2400 and 2900 Å. Below 60 km, the densities are within a factor of two of the daytime photochemical equilibrium, as represented by Johnson's late afternoon measurement of June 14, 1949. Above 60 km, the ozone density increased with altitude, with its maximum increase, a factor of 6 over the day time value, occurring at 63 km.

511. Regener, Victor H., 1954: On the vertical distribution of atmospheric ozone. Scientific Report No. 2, New Mexico Univ. AF 19(122)-381. /R/

512. Regener, Victor H., 1960: On a sensitive method for the recording of atmospheric ozone. J. Geophys. Res., 65 (12), 3975-3977. /R/

513. Regener, Victor H., 1960: Atmospheric ozone. Final Report, New Mexico Univ. AF 19(604)-1950.

The work under this contract from (Aug. 1956 to May 1960) covered, essentially, the development of a chemical-type telemetering ozone sonde for sounding balloon flights, as well as the development of an ozone meter for recordings of atmospheric ozone from aircraft. The wet-chemical ozone sonde is described in Scientific Report No. 1 dated Dec. 26, 1957. The principle of operation of the wet-chemical aircraft recorder is described in the Automatic chemical determination of atmospheric ozone by V. H. Regener. Advances in Chemistry Series, No. 21, p. 124-127, 1959. The adaptation of this method to the recording of ozone from aircraft is described in this Final Report. This report also contains an account of test flights made with the balloon sonde and with the aircraft recorder. In the final months of this contract a new principle was employed and tested for the measurement and for the recording of atmospheric ozone. This new method consists of using the well-known chemiluminescence of certain chemicals in the presence of ozone for the quantitative determination of ozone. A substantial improvement of the state of the art could be achieved through the use of a dry chemiluminescent substance, and it was therefore decided that further efforts on our part should be directed toward the perfection of such a device under the subsequent Contract No. AF 19(604)-7211. It has become clear at the time of this writing that the new method (V.H. Regener, On a sensitive method for the recording of atmospheric ozone, Journal of Geophysical Research, 65:3975-3977, 1960, should be used in preference to our older methods. It is with this in mind that the present report, while giving a certain amount of unpublished information about our wet-chemical aircraft recorder, does not go into great detail. It should be remembered, in this connection, that wet-chemical methods remain valuable for purposes of calibration, since they represent the only convenient means of determining small concentrations, of ozone on an absolute scale. /MA/

514. Regener, Victor H., 1963: Ozone measuring devices. Final Report, New Mexico Univ., 39 p. AF 19(604)-7211, AFCRL-64-212, AD-429 514.

The contract provided for the conduct of studies and experimental investigations toward the development of an inexpensive, balloon-borne, expendable, dry-chemical device for measuring atmospheric ozone concentrations from the surface to 40 km.

The contract also provided for a determination of the feasibility of weight reduction of the wet-chemical ozonesonde developed earlier. This portion of the schedule was not pursued in view of the promising developments of the dry-chemical sonde which took place soon after this contract went into effect. The pressure of this work also prevented the conclusion of a study on local variations of atmospheric ozone and its relationship to meteorological conditions, which formed a part of the contract provisions. Only brief mention of the extent of this latter activity is made in this Report.

The contract further specified that drawings and specifications be prepared for the dry-chemical sonde, and that 100 sondes, together with calibration equipment, be delivered to Air Force Cambridge Research Laboratories. Additional requirements were included for the development of a chemiluminescent-type aircraft recorder, and for the delivery to Air Force Cambridge Research Laboratories of a chemiluminescent surface ozone recorder. These provisions of the contract were carried out.

The initial design stage of the chemiluminescent method dates back to the last months of the predecessor Contract AF 19(604)-1950, as reported in the Final Report under that contract, dated September 21, 1960.

Scientific Report No. 1 under the present contract, dated July 21, 1960 describes the principle of the chemiluminescent method as applied to an ozone sonde. The first public presentation of the chemiluminescent ozone sonde technique was given by V. H. Regener at the XII Assembly of the I. U. G. G. in Helsinki, Finland, on August 4, 1960.

In this Final Report a description is furnished of the essential technical details of the chemiluminescent ozone balloon sonde and of its adaptation to ozone recordings from pressurized aircraft. A description of the ozone generator/calibrator and of the chemiluminescent surface recorder is also included.

515. Regener, Victor H., 1964: Measurement of atmospheric ozone with the chemiluminescent method. J. Geophys. Res., 69 (18), 3795-3800.

Techniques are described for the measurement of atmospheric ozone, using the chemiluminescent reaction between ozone and rhodamine B. Details are given for a balloon sonde, for an aircraft-installed ozone meter, and for a surface ozone recorder.

516. Rice, M. L., and G. Thuronyi, 1959: Annotated bibliography on ozone in the atmosphere, Part I. Meteorological Abstracts, 10 (5), 759-794; Part II. Meteorological Abstracts, 10 (6), 920-957. [R]

517. **Sabin**, Robert L., and Charles F. Mozer, 1959: Project Ozarc. In Conference on Stratospheric Meteorology, Minneapolis, Aug. 31-Sept. 3, 1959, Papers of the Conference, 3 p.

The Physical Science Laboratory of the New Mexico State University, in cooperation with Dr. Clarence Palmer of the Institute of Geophysics, Univ. of California at Los Angeles, and with the Office of Naval Research, is conducting a research program to measure the altitude and latitude variation of atmospheric ozone concentration. The Paetzold ozone radioprobe system is being modified for flight in the Arcas Rocket. A telemetering transmitter compatible with the GMD-1 receiver has been designed. A portable ground station has been designed for recording the output of the GMD-1 receiver. It is planned to fire a series of Arcas Rockets from three islands in the Pacific Ocean near the equator during the vernal and autmnal equinoxes. Parachutes will be deployed at the peak of the rockets' trajectories and ozone concentration will be measured during parachute descent from 150,000 ft to 50,000 ft. Data transmitted from the airborne units will be recorded at the GMD-1 sites. A WWV receiver at each ground station will supply a time standard. Parachute altitude will be determined by radar tracking. /MA/

518. **Sakai**, I., and T. Tamura, 1951: The trial manufacture of ozone radiosonde. J. of the Aerological Observatory (Japan), 5, 97-98. /R/

519. **Schotland**, R. M., and Herman Newstein, 1961: The sounding of the atmosphere by indirect means, Pt. 4. Final Report, New York Univ. Cwb-9763.

To determine the vertical distribution of ozone in the atmosphere it is necessary to measure the magnitude of the backscattered light as a function of wavelength, since the transmitted pulse progresses vertically upward through the atmosphere. The purpose of this section of the report is to present a system block diagram of the electrical and mechanical circuits which will be used in the field trial of the instrumentation. Circuits in the receiver system, in the projector system and the vertical alignment of optical system are summarized.

520. **Sheppard**, P. A., 1961: Research on the vertical distribution of atmospheric ozone by methods of infra-red spectrography and related proglems. Final Summary Report, Imperial College of Science and Technology. AF 61(052)-84.

The object of this investigation has been to develop, test and utilize a reliable method of measuring the vertical distribution of atmospheric ozone from infrared sky emission measurements in the 9.6 μ ozone band, taken with a high resolution spectrometer. The site of the observations is the field station of Imperial College, near Ascot, about 40 km west of London. It is known that the radiation received from the sky in the ozone band is significantly affected by the atmospheric continuum due to the water vapour bands at 6.3 μ and 50 μ, unless there is a very small amount of water vapour above the observing site. Consequently the properties of this continuum must be known. Scattering and emission by atmospheric aerosol, at least when the latter is relatively dense, may also perhaps affect the sky emission significantly. In order to obtain the vertical distribution of ozone from a set of infrared sky emission measurements, it is then necessary to know the following: (1) The vertical distribution of temperature and humidity. (2) The absorption coefficient $k(\nu)$ due to the water vapour continuum for the frequencies ν used for ozone measurements. (3) Transmission functions of ozone at the frequencies concerned from any level in the atmosphere to the ground as a function of zenith angle. Radiosonde data nearest in time at Crawley 50 km SE of Ascot, were used in the analysis. The manner of obtaining the other relevant information, the basis of the analytical procedure and a preliminary assessment of initial results are described briefly.

521. Shimizu, M., and M. Yamasaki, 1959: Observation of the vertical distribution of ozone by an airborne spectrograph, Part 3. J. of the Aerological Observatory (Japan), 6, 93-96. /R/

522. Stair, R., and W. W. Coblentz, 1938: Radiometric measurements of ultraviolet solar intensities in the stratosphere. J. Res. NBS, 20, 185-215. /R/

523. Stranz, von D., 1948: Ozonradiosonde. Trans. Chalmers Univ. Technol., Gothernburg, Sweden, Nr. 72, (Reports from the Research Laboratory of Electronics, Nr. 6). /R/

524. Taba, H., 1961: Ozone observations and their meteorological applications. World Meteorological Organization, WMO (Pub.) No. 108. TP. 46 (Technical Note No. 36), 45-48.

A summary and review of knowledge of atmospheric ozone instrumentation and observation practice and results of such observations, to serve as a guide to current practice and the scope of the subject. The mechanisms responsible for ozone production are reviewed and solar UV rays considered the most effective agent. The familiar photo-chemical theory of ozone production is considered insufficient for clarifying observational evidence. The studies of ozone distribution in space and time in the Northern Hemisphere showed a maximum ozone content in spring and a minimum in autumn with a maximum amplitude at 70°N and a minimum at the equator. The maximum concentration of ozone was observed at 25 km altitude. The diurnal and annual variations seem to be related to weather conditions. It is assumed that ozone is produced in the upper stratosphere and subsequently brought downward by air motion. Some ozone characteristics related to pressure changes were plotted on constant pressure maps. The vertical motion of ozone was discussed on the basis of R. J. Reed's data. The observations of ozone in the Arctic, where rapid transition from winter to summer occurs with a consequent permanent warming effect and a decrease in the intensity of air circulation at the midstratosphere levels, showed a rapid increase in total ozone which takes place in the late winter or early spring. A comparison of 10 days running means of total ozone and 100 mb temperature reveals the relationship between long period changes of these two elements in the Arctic. /MA/

525. **Vassy, A.**, 1958: Radio-sonde spéciale pour la mesure de la répartition verticale de l'ozone atmospherique /Special radiosonde for measuring vertical distribution of atmospheric ozone/. J. Sci. Météorol., 10, 63-75. /R/

526. **Vassy, Arlette**, 1960: Un nouvel ozonomètre enregistreur /A new ozone recorder/. Beiträge zur Physik der Atmosphäre, 32 (3/4), 277-282.

A new model of chemical ozone recorder, the construction of which is simpler and not so delicate as the one which was previously realized, is described. The essential of the transformation consists in the utilization of electromagnetic valves for the admission and the drainage of the control solution. Some results obtained at the Observatory of the Pic du Midi with this apparatus are shown. /MA/

527. Venkateswaran, S. V., 1960: Synoptic studies of atmospheric ozone by means of the ARCAS rocket. Presented at the American Rocket Society 15th Annual Meeting, Washington, D.C., December 5-8, 1960. /R/

528. Venkateswaran, S. V., James G. Moore, and Arlin J. Krueger, 1961: Determination of the vertical distribution of ozone by satellite photometry. J. Geophys. Res., 66 (6), 1751-1771.

The Echo communications satellite (1960 Iota I) launched by the United States on August 12, 1960, is designed to be a good reflector of visible solar radiation. Under certain favorable orientations of its orbital plane, ground observers are able to watch it enter (and leave) the earth's shadow. Immediately before and after such observable eclipses, the satellite is illuminated by radiation that has been modified as a result of a long traverse in the earth's atmosphere. In wavelengths near 6000 Å, the modification is one of attenuation (extinction) caused by two distinct physical processes: scattering by air molecules, and absorption by ozone present mainly in the lower stratosphere and possessing weak absorption bands (the Chappuis bands). If in this region of the solar spectrum we measure the differential attenuation between a pair of properly selected wavelengths, and are able to subtract out the contribution due to differential scattering, we can isolate the differential absorption due to ozone, and hence, derive the average concentration of this constituent in the path of the solar ray instantaneously incident on the satellite. By making the measurements at successive instants, the altitude distribution of the ozone concentration can also be determined. Even though ozone concentration does not reach values higher than 10^{-6} of the air concentration at any altitude in the earth's atmosphere, the long ray paths involved in the satellite illumination make it possible to determine this concentration with sufficient accuracy. Alternatively, if the wavelengths selected are such that the differential ozone absorption is negligible, we have in principle a method of determining the air density at various heights from the differential scattering alone. In this paper we present the details of the theory, and report on some preliminary determination of the ozone distribution obtained by monitoring the Echo satellite in two wavelength bands centered at 5900 and 5295 Å, respectively.

529. Vigroux, E., and A. Debaix, 1963: Results of observations on atmospheric ozone by the infrared method, deduced from data obtained in Arosa (Switzerland). Liege Univ. Institut d'Astrophysique, Geophysics TN-2. AF 61(514)-962.

Vertical distributions of the atmospheric ozone have been deduced from the infrared observations made in Arosa from January 1957 to November 1958 - Critical view of the method - The results are used to find certain correlations.

530. Wardle, D. I., C. D. Walshaw, and T. W. Wormell, 1963: A new instrument for atmospheric ozone. Nature, 199, 1177-1178.

This is an improvement on the standard instrument, the Dobson spectrophotometer, in that sunlight or bright moonlight is not necessary for its' operation, thus enabling routine observations during the polar night. The principle of operation of the instrument is the measurement of the relative intensities of two stellar u.v. wave-bands one of which is more strongly absorbed by ozone than the other. The bands are separated by a grating system, and the intensities measured using photomultipliers. The results of a typical observation are given. /PA/

531. Wei, Ding-wen, 1963: The non-uniqueness of the solution for the vertical distribution of ozone from the calculation by the Umkehr method B. Scientia Sinica (Peking), 12 (7), 1065-1070. (First pub. in Chinese in Acta Geophysica Sinica, 11 (2), 123-135 (1962).)

The Umkehr method B given by Ramanathan and Dave in 1957 is one of the usual methods for measuring the vertical distribution of the atmospheric O_3 and is being used now all over the world. In this paper this method is discussed. It has been demonstrated that several substantially different vertical distributions of O_3 in the atmosphere with this method.

532. Wexler, H., and J. E. Caskey, Jr., eds., 1963: A satellite experiment to determine the vertical distribution of the ozone concentration in the earth's atmosphere. In International Symposium on Rocket and Satellite Meteorology, 1st, Wash., D.C., 1962, Proceedings. Amsterdam, North-Holland Pub. Co., 299-302.

Experiments to measure the vertical distribution of ozone in the earth's atmosphere are to be included in the second British/U.S.A. satellite. These experiments are briefly described and the results of one rocket ascent using this type of instrument given. /MA/

533. Wulf, O. R., and J. E. Zimmerman, 1954: A method for the measurement of atmospheric ozone using the absorption of ozone in the visible spectrum. Smithsonian Institution, Misc. Collections, 123, (Pub. 4177). [R]

534. Yokoyama, M., 1962: Comparison of total ozone amounts measured with direct sunlight and other light sources. J. Met. Res., 14, 802-805. (Also issued in J. Aerological Observatory, 7, 164-167 (1963).)

A comparison of the total ozone amounts computed from the measurements by Dobson's spectrophotometer for A and D wave lengths of direct sunlight and other light sources at Tateno during 1959 to 1961. The results obtained were summarized as follows: 1) The ozone amount measured with the direct sunlight through thin cloud layer scarcely shows the effect of cloud, while that with the sunlight through thick or dark cloud layer tends to exceed the normal values. 2) In spite of the various weather conditions, the mean value of ozone amount measured with the sunlight from the zenith of cloud sky is nearly equal to that with the direct sunlight, while the former, in detailed inspection, is larger than the latter at $\mu = 3$. [MA]

535. Znamenskii, A. A., 1961: Rezul'taty sravnenii razlichnykh ozonometricheskikh priborov, provedennogo v Glavnoi geofizicheskoi observatorii im. A. I. Voeikova [Results of comparisons between various ozone meters conducted at the Main A. I. Voeikov Geophysical Observatory]. Atmosfernyi ozon, 187-194.

The comparison of some ozonometric instruments were made in the CGO on July 2, 4, 5 and 7, 1959. Four types of ozonometers were compared: universal ozonometer of CGO, spectrophotometer of type Cϕ-4, spectrophotometer of the Moscow State University, and the Dobson spectrophotometer. The results of comparison are given which are discussed in connection with use of these instruments at the ozonometric stations of the U.S.S.R. [MA]

PRESSURE SENSORS

See also: Air Force Proving Ground Command, 1956: Employment and suitability test of the AN/AMT-6 parachute radiosonde system. (65)
Bendix Corporation, 1962: Cricketsonde meteorological rocket and instrument package. (81)
Cato, G. A., 1964: Ultra-high altitude measurement systems for pressure, density, temperature and winds. (585)
Champion, K. S. W., and A. C. Faire, 1964: Falling sphere measurements of atmospheric density, temperature, and pressure, up to 115 km. (587)
Coppola, A. A., 1963: Radiosonde Set AN/DMQ-6. (90)
Pearson, P. H. O., 1963: Measurement of atmospheric density, temperature, and pressure at Woomera, on 29th March 1962 by the falling sphere method. (607)
Smith, W., L. Katchen, P. Sacher, P. Swartz, and J. Theon, 1964: Temperature, pressure, density and wind measurements with the rocket grenade experiment, 1960-1963. (241)

536. **Adams, F. L.**, 1961: A new rocketsonde hypsometer. Fall Instrument-Automation Conference and Exhibit, Los Angeles, California, September 11-15, 1961, Preprint No. 172-LA-61. /R/

537. **Ainsworth, J. E., D. F. Fox, and H. E. LaGow**, 1961: Upper-atmosphere structure measurement made with the pitot-static tube. J. Geophys. Res., 66 (10), 3191-3212. (See also: NASA TN D-670, 47 p.) /R/

538. **Arnold, A.**, 1961: The pressure-versus-height relationship, a measurement question. U.S. Army Signal Research and Development Lab., USASRDL TR-2165. AD 251 541. /R/

539. **Bendix Aviation Corporation**, 1959: Final Report AN/AMQ-15 air weather reconnaissance system, expendable pressure sensor rocketsonde, phase 1. Bendix Aviation Corporation, Report No. 1329. /R/

540. Benson, J. M., 1956: Thermopile vacuum gages having transient temperature compensation and direct reading over extended ranges. Preprint of paper delivered at the 1956 Committee on Vacuum Techniques, October 9-12, Chicago, Illinois. /R/

541. Brombacher, W. G., 1949: Some problems in the precise measurement of pressure. Instruments, 22, 355-358. /R/

542. Brombacher, W. G., 1957: Force-balance systems for measuring static pressure, pressure altitude and Mach number. National Bureau of Standards, NBS-5296. /R/

543. Brombacher, W. G., V. H. Goerke, and F. Cordero, 1940: Sensitive aneroid diaphragm capsule with no deflection above a selected pressure. J. Res. NBS, 24, 31-32. /R/

544. Cambridge Systems, Inc., 1964: Full-range hypsometer, Model 137. Cambridge Systems, Inc., Technical Data Bulletin 137B1, 1 p.

545. Capone, F. J., 1961: Wind-tunnel tests of 7 static-pressure probes at transonic speeds. National Aeronautics and Space Administration, NASA TN D-947, 30 p. /R/

546. Carmer, D. D.: SM/1 thermo-conductivity densitometer. Servomechanisms, Inc., (unpublished). /R/

547. Conover, Walter C., 1961: Radiosonde modulator using a hypsometer. Bull. Am. Met. Soc., 42 (4), 249-251. /R/

548. Conover, Walter C., and W. G. Stroud, 1958: A high-altitude radiosonde hypsometer. J. Met., 15 (1), 63-68. /R/

549. Decker Corporation, 1961: Final Report. Nonr 3000(00) (X).

(Describes diaphragm pressure sensors for upper air pitot-static tube measurement.) /R/

550. Downing, J. R., and G. Mellen, 1946: A sensitive vacuum gage with linear response. Rev. Sci. Instr., 17, 218-223. [R]

551. Dowski, Edward R., 1961: High-altitude hypsometer radiosonde tests. U.S. Army Signal Research and Development Lab., USASRDL TR-2242, 15 p.

Discusses tests made to determine the altitude accuracy of the high-altitude radiosonde hypsometer. Altitudes obtained from hypsometer and baroswitch measurements were compared to those from a four-station phototheodolite network used as an altitude standard. Of the flight tests evaluated, the hypsometer in combination with a baroswitch had an altitude accuracy of 0.5 to 1% at 100,000 ft altitude mean sea level. It was also determined that the hypsometer may be switched in at any pressure less than 30 millibars. [MA]

552. El-Moslimany, M. A., 1960: Theoretical and experimental investigation of radioactive ionization gauges. Michigan Univ. Research Institute, Scientific Report No. HS-1. AFCRL TN-60-658. [R]

553. Golden, A., 1959: A manual method for solution of the hydrostatic equation. U. S. Army Signal Research and Development Lab., USASRDL TR-2006. AD 226 687. [R]

554. Goodyear, R. S., M. Sapoff, J. Gecsey, J. M. Ruskin, and R. J. Strack, 1954: Development of "full range radiosonde hypsometer" for U. S. Signal Corps, Evans Signal Laboratory. Victory Engineering Corp. DA-36-039-SC-52632. [R]

555. Hausner, A., 1959: A guide to selection and use of dynamic pressure transducers. Diamond Ordnance Fuze Lab., TR-814. AD 233 007. [R]

556. Havens, R. J., R.T. Koll, and H. E. LaGow, 1950: A new vacuum gage. Rev. Sci. Instr., 21, 596-598. [R]

557. Havens, R. J., R. T. Koll, and H. E. LaGow, 1952: The pressure, density, and temperature of the earth's atmosphere to 160 kilometers. J. Geophys. Res., 57, 59-72. /R/

558. Horvath, J. J., R. W. Simmons, and L. H. Brace, 1962: Theory and implementation of the pitot-static technique for upper atmospheric measurements. Michigan Univ., Scientific Report No. NS-1. /R/

559. Israel, Guy, 1961: Manomètre thermique utilisable à bord de fusées depuis le sol jusqu'à 90 kilomètres /Heat manometer utilizable aboard rockets from the surface to 90 kilometers, Pt. 1/. J. de Mécanique et de Physique de l'Atmosphère, Sér. 2, 3 (10), 73-99. Pt. 2, Ibid., 3 (11), 101-117. (Also in Académie des Sciences, Comptes Rendus, 251 (18), 1892-1894, (1960).

Pt. 1 of this study is divided into two chapters of which the first reviews the various correlations between the three parameters of the atmosphere, pressure, temperature and density, and surveys the aerodynamic, thermal and transfer phenomena relating to an engine passing through a vertical portion of the atmosphere. The method of determining the three parameters of the upper atmosphere, pressure, temperature and density, starting from measurements from rocket soundings is briefly explained. The field investigated extends from the atmospheric pressure at the surface to pressure of a few microns of mercury up to 90 km. Only the direct methods of determining pressure, temperature and humidity are mentioned: Taylor and Macoll's aerodynamic method, the Pitot tube for supersonic measurements, the Russian methods of separate pressure and temperature measurements and static-pressure measurements by means of rockets of the Véronique type. A correlation is established between the surrounding pressure investigated and the static pressure measured. Ch. 2 of Pt. 1 deals with the thermal Pirani type manometer having two sensible elements. This instrument measures the low pressures by using the conductivity of the bases. Characteristics of the manometer, the mounting of the various elements and their working principles are described in detail. The two sensible elements of the manometer are: a) a metallic wire active in the low pressure region and b) an indirectly heated miniature thermistor active in the high pressure region. Pt. 2 is a study of the practical realization of such an apparatus intended to measure static pressure and of its utilization aboard Véronique rockets. The author successively deals with the influence of temperature variations of the shell on the measurement of pressure, the thermal compensation and the control of the shell temperatures. The conclusion is devoted to the practical use of the double gage and to the use of a Véronique rocket for measuring meteorological elements. [MA]

560. **Israel**, Guy, 1961: Emploi d'un manomètre thermique pour la mesure de la pression entre zero et 90 km [Use of a heat conductivity manometer to measure pressure between zero and 90 km]. In International Space Science Symposium, 2nd, Florence, April 1961, Space Research, Vol. 2: Proceedings of the 2nd Symposium, 1013-1017.

A heat conductivity manometer has been designed for pressure measurement from zero to 90 km. A second sensitive element has been added to the conventional metallic wire element in order to extend the pressure range. This second element is a bead thermistor which is heated indirectly by a metallic filament. The output signal of a Kelvin double bridge, in which these two elements are in opposed places in the two branches, is directly transmitted by telemetry. The manometer is compensated for changes of the wall temperature. Two such instruments have been used in a Véronique flight in Feb., 1961 at Colomb-Bechar. The gages were placed on each side of the rocket, about 1.5 m below the nose. The effect of rocket attitude on our measurements has been controlled by magnetic aspect sensors. [MA]

561. **Jones**, Leslie M., F. F. Fischbach, and J. W. Peterson, 1962: Atmospheric measurements from satellite observations of stellar refraction. Michigan Univ., Technical Report (unnumbered). NASw-140.

A method of obtaining atmospheric density, temperature and pressure data by observing refraction of stellar images with instruments in a satellite is described. Data acquisition and altitude range is such as to permit making of weather maps between 25 mb and perhaps 500 mb. [STAR]

562. **LaGow**, H. E., and J. Ainsworth, 1956: Arctic upper-atmosphere pressure and density measurements with rockets. J. Geophys. Res., 61, 77-92. [R]

563. Liu, V. C., 1956: On a pitot-tube method of upper-atmosphere measurement. J. Geophys. Res., 61, 171-178. /R/

564. Mikhneivch, V. V., 1957: Izmerenie davleniya v verkhnei atmosfere /Pressure measurements in the upper atmosphere/. Uspekhi Fizicheskikh Nauk, 63, 197-204. /R/

565. Nagy, A. F., N. W. Spencer, H. B. Niemann, and G. R. Carignan, 1961: Measurements of atmospheric pressure, temperature, and density at very high altitudes. Final Scientific Report, Michigan Univ., 57 p. DA-36-039 SC-78131.

This report describes in detail the results of a theoretical study of the general measurement problem and of the work in the development of suitable sensors, of associated electronic circuits, of a high-vacuum system for study and calibration of the sensors, and of the nose-cone system to carry and eject the experiment. The presentation of the results of the theoretical study includes graphs showing variation of relative chamber pressure with roll angle for particular velocities and altitudes and expected pressure versus altitude variation for a typical Aerobee 150 flight, and a sketch of a suggested mounting position of pressure sensors. The discussion of sensor development is illustrated by a functional diagram of an Omegatron; photographs of a prototype Omegatron assembly, the Omegatron filament and the Westinghouse WX-4520 Bayard-Alpert ionization gage. The Bayard-Alpert ionization gage assembly is shown in a drawing. A typical spectrum obtained by the Omegatron is shown in a graph. Collector current versus collector voltage characteristics of a WX-4520 gage and reference pressure vs. collector current characteristics of a WX-4520 gage for dry air and for N are shown graphically. The vacuum calibration system is described and is shown in a block diagram and in photographs. The electrometer amplifier is shown in a photograph and circuit diagrams are presented for the various components. The Aerobee 150 nose-cone and extension assembly, designed to carry the instrument package in the rocket under vacuum up to an altitude of about 100 km where it is to be ejected into the atmosphere, is described in detail and shown in a reduced annotated drawing with very small lettering.

566. Pápai, László, 1960: Főizobárszint-magasságok meghatározásának hibái /Errors in determining heights of the main pressure levels/. Időjárás, 64 (6), 381-384.

Errors made by various observation stations measuring the height of the main pressure levels are generally due to the 15 types of radiosondes applied throughout Europe. To meet the synoptic requirements author suggests the use of similar types of radiosondes on large areas. Errors might occur by the use of different diagram sheets, some of them emphasizing the determination of special type of meteorological elements. A further error factor is of subjective type, attributed to the sometimes inadequate handling and presentation of the results obtained. /MA/

567. Parametrics, Inc., 1961: Design, development, and manufacture of an electroluminescent pressure transducer. Final Report, Parametrics, Inc. NAS5-796, AD 270 958. /R/

568. Pinkau, K., and H. Selk, 1963: Radiosonde for exact measurement of air pressure and various temperature values. Atomkernenergie, 8 (10), 365-370.

A radiosonde was constructed for the simultaneous measurement of pressure and several values of temperature. Pressure-sensitive signals for transmission are obtained by varying the inductivity of an oscillator using aneroid capsules. Temperature measurement is carried out using monostable multivibrators which return to their ground state after a time which is determined by the resistance of a thermistor. Initiating and return pulses are transmitted and the time elapsing between them is a measure for the temperature. The thermistors can be connected by long cables to the electronic system, thus permitting measurements at any position required. Accuracy of temperature measurement is about 1° centigrade from $+30^{\circ}$ to -30°C. Accuracy of pressure measurement is about 0.2 torr at 5 torr pressure. /PA/

569. Rosemount Engineering Company: Model 855 aerodynamically compensated pitot-static tube and Models 850 and 852 conventional pitot-static tubes. Rosemount Engineering Company, Bulletin 116010. /R/

570. Rosemount Engineering Company, 1962: REC Model 800E pressure transducer. Rosemount Engineering Company, Bulletin 46224A. /R/

571. Science Communication, Inc., 1960: Properties of the upper atmosphere, rocketsonde and satellite measurements of pressure, temperature, density and composition through early 1960. Science Communication, Inc. Nonr 3071(00), AD 243 886. /R/

572. Shionomisaki Weather Station, 1963: An experiment on the strain of sonde aneroid barometer. U.S. Army Missile Command, Redstone Scientific Information Center, RSIC-110, 5 p. AD 426 828.

573. Sicinski, H. S., N. W. Spencer, and W. G. Dow, 1951: Rocket measurements of upper atmosphere ambient temperature and pressure in the 30- to 75-kilometer region. J. Appl. Phys., 25, 161-168. /R/

574. Spencer, N. W., 1958: Research in the measurement of ambient pressure, temperature, and density of the upper atmosphere by means of rockets. Final Report, Michigan Univ. AF 19(604)-545, AD 203 480. /R/

575. Spencer, N. W., H. F. Schulte, and H. S. Sicinski, 1954: Rocket instrumentation for reliable upper-atmosphere temperature determination. Proc. IRE, 42, 1104-1108. /R/

576. Spencer, N. W., R. L. Boggess, L. R. Brace, and M. A. El-Moslimany, 1958: A radioactive-ionization-gage pressure-measurement system. Michigan Univ. Engineering Research Institute, Scientific Report No. ES-1. AF 19(604)-545. /R/

577. Spencer, N. W., and R. L. Boggess, 1959: A radioactive ionization gage pressure measurement system. J. Am. Rocket Soc., 29, 68-71. /R/

578. Victory Engineering Corporation, 1955: VECO Model M163 Hypsometer. Victory Engineering Corporation, Form F-83, 4/55. [R]

579. Wagner, W. C., 1960: Hypsometer for constant level balloon. Air Force Cambridge Research Labs., Instrumentation for Geophysics and Astrophysics, No. 14, AFCRC-TR-60-262. [R]

580. Wolber, W. G., 1964: Development of a hypsometer for atmospheric sounding. Final Engineering Report, Bendix Corporation, Bendix-RLD 2601, 38 p. DA-36-039sc84992, AD 607 373.

The summarized program resulted in the development of a miniature hypsometer for rocket-borne dropsonde application. The developed unit met or exceeded the contract specifications; it is believed that its range could easily be extended to measure altitudes to 300,000 feet. The sensing technique, the sensor's design and development, the laboratory performance tests, the actual rocket flight tests, and the development of a pressure calibration stand are discussed.

581. Wright Instruments, Inc., 1959: A survey of pressure and density sensors and associated problems for the NOL HASP program. Final Report, Wright Instruments, Inc. NOL-N 60921-5608, AD 218 681. [R]

DENSITY SENSORS

See also: Ainsworth, J. E., D. F. Fox, H. E. LaGow, 1961: Upper-atmosphere structure measurement made with the pitot-static tube. (537)

Dobson, G. M. B., 1963: The temperature and density of the air at great heights. In Exploring the Atmosphere, Chapter 3. (14)

Jones, L. M., F. F. Fischbach, and J. W. Peterson, 1962: Atmospheric measurements from satellite observations of stellar refraction. (561)

Lenhard, R. W., and M. P. Doody, 1963: Accuracy of meteorological data obtained by tracking the ROBIN with MPS-19 radar. (302)

Masterson, J. E., 1964: The strato-mesopheric meteorological rocket. (126)

Nagy, A. F., N. W. Spencer, H. B. Niemann, and G. R. Carignan, 1961: Measurements of atmospheric pressure, temperature, and density at very high altitudes. (565)

Nordberg, W., 1964: Rocket soundings in the mesosphere. (140)

Quiroz, R. S., J. K. Lambert, J. A. Dutton, 1963: Upper-stratosphere density and temperature variability determined from meteorological rocket network results, 1960-1962. (277)

582. Bartman, F. L., L. W. Chaney, L. M. Jones, and V. C. Liu, 1956: Upper-air density and temperature by the falling-sphere method. J. Appl. Phys., 27, 706-712. /R/

583. Bragin, Yu. A., 1964: Density measurements by a time-of-flight method. In Proceedings of the Central Aerological Observatory, No. 42, G. A. Kokin and N. S. Livshits, eds., National Aeronautics and Space Administration, NASA TT F-141, 132-142.

A method is suggested for measuring the density of a gas in the pressure range $10-10^{-3}$ mm Hg. Collision processes of the ions with the molecules can be investigated by this method. An instrument for density measurements in the pressure range $10-10^{-1}$ mm Hg is described.

584. Cambou, F., F. Cotin, and H. Reme, 1964: New measuring apparatus for atmospheric pressure using a pulse-operated ionization gauge. Ann. Geophys., 20 (3), 346-347.

An ionization gauge with associated electronics gives the density of the atmosphere as a number of pulses per unit time. It can be used for measurements aboard balloons or rockets between the sea level and an altitude of 80 km. /PA/

585. Cato, Glenn A., 1964: Ultra-high altitude measurement systems for pressure, density, temperature, and winds. Final Report, Electro-Optical Systems, Inc., EOS Report 3780-Final, 149 p. NAS8-5226, TP3-81046 (IF).

In this report proposals are made for the measurement of pressure, density, temperature, and winds based on the study of large liquid-fueled launch vehicle requirements. The most promising measurement technique is remote measurement. Here the instruments are located aboard the launch vehicle, but the actual measurement is made remotely in the undisturbed air outside the shock layer. This method avoids placing the instruments in the nose tip where they are lost when the excape rocket is jettisoned. However, the only property amenable to remote measurement is density. Consequently, recommendations for immersion type measurements have been formulated for the other properties. A promising alternative to onboard instrumentation is free flight or dropsonde techniques. Recommendations have been formulated for the alternative techniques also.

586. Champion, K. S. W., 1963: Atmospheric structure and its variations in the lower thermosphere. Air Force Cambridge Research Labs., 20 p. AFCRL-63-873, AD 417 201.

COSPAR Working Group IV (International Reference Atmosphere) appointed rapporteurs to prepare reports on three altitude regions of the atmosphere for presentation at the Fourth International Space Science Symposium at Warsaw. This report is the one prepared for the intermediate altitude region (the lower thermosphere, lying between about 100 and 200 km). This region differs considerably from the lowest one, in which the volume of data makes statistical methods of analysis appropriate. For the highest region, a considerable amount of satellite data is available and the behavior of the atmosphere is reasonably well understood. Some rocket data is available for the lower thermosphere, but most of the measuring instruments are experimental and a major part of the data analysis consists in studying the physics of the various corrections or calibration factors required. At the upper end of the altitude regime some satellite data is available. New density data includes the results from flights of two types of falling spheres at Eglin AFB, Florida, results from the diffusion of chemical clouds at Woomera, Australia and Eglin AFB, and data from drag effects on three satellites with perigee altitudes near 200 km. The satellite data indicates a dependence of density on the value of the magnetic A_p index. Otherwise, the data shows more variation with the method of measurement and data reduction than actual variation of atmosphere. Recent values of temperature include those deduced by the author from the density data and measurements by Blamont based on the broadening of the sodium and potassium resonance lines and from aluminum oxide bands. Again, genuine atmospheric variations are obscured by systematic variations between the different measurement techniques. Probably the most important property of the lower thermosphere is composition. In this region there are major changes with altitude, primarily due to dissociation of oxygen and nitrogen. The composition throughout the upper atmosphere (including the exosphere) is almost entirely determined by that in the lower thermosphere. In addition to recent theoretical models, new results obtained with mass spectrometers and solar ultraviolet absorption are discussed.

587. Champion, K. S. W., and A. C. Faire, 1964: Falling sphere measurements of atmospheric density, temperature, and pressure, up to 115 km. Air Force Cambridge Research Labs., Environmental Research Papers No. 34. AFCRL-64-554, AD 605 273.

Newly developed airborne instrumentation has made it possible to extend the measurements of atmospheric density, temperature, and pressure from the previous upper limit of 90 km to 115 km by means of the 7-in. rigid sphere method. A brief description of the instrumentation is given. Results of four rocket-borne experiments are presented and compared with the U.S. Standard Atmosphere, 1962, and a winter atmosphere for 30^{o} latitude.

588. Chubb, T. A., 1961: Absorption method for measuring atmospheric density. In Initiation of the meteorological rocket network. Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised August 1961, p. 235. /R/

589. Control Instrument Company, Inc.: Supplementary report study phase -- Part I air density sensing equipment. Douglas Aircraft Company. Douglas Prime Contract Nonr 1076, AD 140 617. /R/

590. Cross, Jon L., 1963: Progressive developments in the design of an airborne UHF transmitter for the falling sphere experiment. Scientific Report, Utah Univ., Upper Air Research Labs., 76 p. AF 19(604)-6658, AFCRL-63-922, AD 601 818.

In this report the development of a pulsed telemetry transmitter to be incorporated into a 7 inch sphere containing instrumentation to measure high altitude air density is discussed. A 20 watt, 730 mc tube type pulse transmitter is described. Construction details and checkout procedure are also included. The theory and design criterion of a 30 watt pulse modulated transmitter using ceramic planar triode tubes with coaxial resonators is also presented. The final section suggests the development of a transistorized, frequency modulated transmitter operating at 400 mc. A simple method of obtaining the frequency modulation is developed along with suggested circuits and their power gains for the remaining sections of the transmitter. The power output is conservatively estimated at 825 mw.

591. Durbin, E. J., G. J. Born, 1962: Survey of methods of studying density of atmosphere. Instrument Society of America, Proc. Preprint 33.3.62 for meeting Oct. 15-18, 7 p.

Various methods used in density measurement of upper atmosphere are compared with regard to how well they perform measurement in free undisturbed air. / EI /

592. Eskridge, Richard, 1963: Atmospheric density measurement by use of radioisotope techniques. Air Force Institute of Technology, GA/Phys/63-4, 77 p. AD 418 989.

Interactions of radiation particles and rays with air molecules have been investigated as means of measuring air density. These interactions include transmission and scattering of alpha particles, beta particles and gamma-rays. Only the scattering of beta particles and gamma rays are found to be suitable for use in density measurement.

Environment effects on the accuracy of a radioisotope density gage are examined. The shock layer, and possibly cosmic radiation background, are the sources of the largest errors. Electric field, magnetic field, and boundary layer effects are believed to be small. The overall error in density measurement, indiced by the environment, is estimated to be between ten and fifteen percent.

The results of experiments, with the use of the scattering of beta particles, to measure air density are reported. Usable data is obtained in the 100,000 to 270,000 foot altitude range. Promethium-147 and strontium-90 yttrium-90 are used as beta particle sources, ant the response of the two sources are compared.

593. Faucher, G. A., R. W. Procunier, and C. N. Stark, 1961: Flight information and experimental results of inflatable falling sphere system for measuring upper air density. Air Force Cambridge Research Labs., GRD Research Notes No. 63, 29 p. AFCRL 685, AD 265 172. /R/

594. Faucher, G. A., R. W. Procunier, and F. S. Sherman, 1963: Upper atmosphere density obtained from measurements of drag on a falling sphere. J. of Geophys. Res., 68 (11), 3437-3450, (also in AFCRL-62-1136).

This paper gives the density profile vs. altitude from 95 to 130 km obtained from drag measurements made directly from within a falling sphere. In the test, an inflatable sphere, 2.74 m in diameter, is ejected somewhere between 80 and 100 km during the ascent of an Aerobee 150 Rocket. At the center of the sphere, supported by an inflated cylindrical strut, are the measuring insttuments and the necessary electronics to telemeter the information continuously throughout the flight. The main sensors are linear accelerometers aligned to measure the X, Y and Z components of acceleration of the sphere from which total drag is obtained. From ejection altitude, the sphere continues to an altitude of approximately 250 km on what is, except for drag, a free-fall trajectory. Measurements of drag acceleration obtained by this method are supplemented by measurements of velocity and position obtained by tracking systems.

595. Friedland, Mary, 1963: Atmospheric density-measuring set AN/DMQ-8. U.S. Army Electronics Research and Development Lab., Technical Report 2371, 24 p.

596. Friedland, Stephen S., Jack Katzenstein, Jack Sherman, and Michael R. Zatsick, 1956: Improved instrumentation for searchlight probing of the stratosphere. Final Research Report, Connecticut Univ., AFCRC-TR-56-278, 118 p. AF 19 (604)-290. (See also: J. Geophys. Res., 61, 415-434)

597. Johnson, Donald L., 1964: X-ray air density determination. Final Report, Giannini Controls Corp., FDL-TDR-64-29. AF 33(657)-11631, AD 601 015.

This report describes the theoretical analyses, component selection, subsystem integration and tests of a breadboard system used to measure air density by scattering X-rays from air molecules. This technique provides a direct means of measuring air density.

The eventual application is density measurement for energy management of re-entry vehicles. Upon re-entry, with the increase in air density, there is a corresponding increase in the number of backscattered X-ray photons.

The breadboard system was tested in a 41-foot diameter altitude sphere at NASA, Langley Research Center. Altitudes from sea level to 200,000 feet were simulated. The results of the test indicate that this technique is indeed useful for this application. Problem areas were uncovered and, using the experience and components available, development of a flyable system can now be accomplished. An excellent test-bed for a flyable system is the X-15 aircraft.

598. Jones, L. M., 1956: Transit-time accelerometer. Rev. Sci. Instr., 27 (6), 374-377. [R]

599. Jones, L. M., J. W. Peterson, E. J. Schaeffer, and H. F. Schulte, 1959: Upper-air densities and temperatures from eight IGY rocket flights by the falling-sphere methods. National Academy of Sciences, IGY Rocket Report Series No. 5. [R]

600. Haycock, O. C., 1960: Improvements in the falling sphere instrumentation. Final Report, Utah Univ., Upper Air Research Lab., AFCRC TR-60-233. AF 19(604)-4956, AD 236 470. [R]

601. Larson, Terry J., and Earl J. Montoya, 1964: Stratosphere and mesosphere densities measured with the X-15 airplane. J. Geophys. Res., 69 (24), 5123-5130.

Density values were obtained in the stratosphere and mesosphere from measurements of impact pressure, velocity, and altitude on six X-15 research airplane flights. A form of the Rayleigh pitot formula was used for density computations. Because of pressure-instrumentation limitations and pressure lag, the maximum altitude for reasonably accurate density determination was considered to be about 65 km. For all six flights, four of which were made in summer, densities at altitudes above 40 km were higher than the U.S. Standard Atmosphere, 1962 values. Temperatures calculated from density-height profiles of two X-15 flights agree well with temperatures measured by rocketsondes launched from the Pacific missile range, Point Mugu, California, near the times of the flights.

602. Leviton, R., 1961: The ROBIN falling sphere. In Initiation of the meteorological rocket network. Inter-Range Instrumentation Group of the Range Commanders' Conference, IRIG Document 105-60, revised August 1961, p. 131. /R/

603. Leviton, R., and W. E. Palmquist, 19tJ: ROBIN -- a meteorological sensor. Presented at the ARS 15th Annual Meeting, Washington, D.C., Dec. 5-8, 1469-60. /R/

604. Leviton, R., and J. B. Wright, 1961: Accuracy of density from the ROBIN falling sphere. Air Force Cambridge Research Labs., GRD Research Notes No. 73. AFCRL 1095. /R/

605. Masterson, John E., 1964: Status of the direct probe sounding technique for density. Bull. Am. Met. Soc., 45 (3), 175.

606. Parametrics, Inc., 1963: Measurement of air density at high altitudes using radioisotopes. Parametrics, Inc., ASD TDR 63-263, 135 p. AF 33(657)-8464, AD 113 668.

A study to determine the feasibility and altitude limitations of radioisotope techniques for the measurement of atmospheric density from a re-entry vehicle was carried out. Both transmission and scattering systems were studied. It is shown that the beta forward scattering principle is superior and this approach is considered in detail. It is difficult to make general statements as to altitude range of applicability, since gauge design depends critically upon such factors as vertical vehicle velocity, aerodynamic effects, principally the thickness of the shock layer at the gauge location, and available space. It is concluded, however, that an upper altitude limit of about

250,000 ft exists for favorable conditions, and that a source strength (either Pm-147 or Sr-Y-90 may be used) of about one kilocurie is required. Usefulness at low altitudes is determined primarily by the thickness of the shock layer, if it is essential to sense ambient density, and this can severely limit performance. On the other hand, the beta scattering approach appears quite promising as a means of measuring the density of air in close proximity to the vehicle surface.

607. Pearson, P. H. O., 1963: Measurement of atmospheric density, temperature and pressure at Woomera on 29th March, 1962, by the falling sphere method. Weapons Research Establishment (Australia), SAD-121, 27 p.

A falling-sphere experiment was conducted at Woomera during the astro-twilight period on 29 March, 1962, to measure atmospheric density, temperature, and pressure. These basic parameters were successfully measured from 320,000 to 230,000 ft. and the results are presented together with an estimate of their acurracy and a description of the trial. /STAR/

608. Peterson, J. W., and K. D. McWatters, 1964: The measurement of upper-air density and temperature by two radar-tracked falling spheres. Michigan Univ., NASA CR-29, 41 p.

Two major lines of investigation have been pursued: the measurement of neutral composition with mass spectrometers, and the measurement of neutral density with falling spheres. The purpose of the work described in this report was to develop an inexpensive technique for probing the atmosphere at relatively high levels using a lightweight sphere to be tracked by radar. It was anticipated that in order to satisfy the cost requirement, the sphere deployment system should be compatible with rocket payloads designed for other functions. Two such systems were developed and successfully flown on Nike-Cajun rockets. The first system employed dual pods, arranged in the Cajun tail section for rearward deployment of two inflatable spheres. The second system employed a single tube in the Cajun nose cone for forward deployment of a single inflatable sphere.

609. Quiroz, R. S., 1961: Seasonal and latitudinal variations of air density in the mesosphere (30 to 80 kilometers). Air Weather Service, AWS TR-151. AD 254 761. /R/

610. Rofe, Bryan, 1962: Mesospheric density and winds determined by the falling sphere method at Woomera. Nature, London, 194 (4835), 1231-1233.

The Weapons Research Establishment has designed rocket-vehicles to cover soundings to a height of 300 kft. Here an account is given of an experiment in which an inflatable sphere was ejected from a rocket and was tracked both optically and by radar to permit the calculation of the density and wind profile. The sphere was in fact, ejected at a height of 384 kft and continued to an apogee of 423 kft. The falling sphere was tracked by two type FPS 16 radars spaced 11 mi apart, two ballistic cameras and a Baker-Nunn satellite camera. The sphere was constructed with 20 gores of 0.0005" metallized "Melinex" and inflated to a super-pressure of 9 mb by isopentane. The cross-sectional area varied from that of a 2 m sphere by 0.25%. Density and wind profiles were determined from the rate of descent and the trajectory using an IBM 7090 computer. Winds were not measurable above 220 kft because of the excessive rate of fall of the sphere. The resultant wind-profiles are illustrated graphically and are compared with a nearby simultaneous radiosonde ascent, a model summer zonal profile and meteor winds. Further experiments are in hand with a view to developing the method for synoptic use. /MA/

611. Schaefer, E. J., and M. H. Nichols, 1961: Mass spectrometer for upper air measurements. J. Am. Rocket Soc., 6, 1773-1776. /R/

612. Schulte, H. F., D. A. Robinson, and J. L. Wagener, 1962: Falling-sphere experiment for upper-air-density: instrumentation development. Final Report, Michigan Univ. Dept. of Aeronautical and Astronautical Engineering, 51 p. AF 19(604)-6185.

The continuing development of the instrumentation for the falling-sphere experiment for upper-air density and temperature is described. A multiple-circuit cavity for the accelerometer, which permitted the elimination of the wire bobbin contact, was developed. A moving iron solenoid caging device resulted in a smaller accelerometer requiring less power than the previous model. A new Attwood's machine permitting laboratory tests at 10^{-3} g was constructed. Electronic circuits were developed to replace the intervalometer motor. Circuits were also devised to permit long transit times and to provide discrimination between start and stop pulses. Four spheres and accelerometers for flight test were constructed. /STAR/

613. Smith, H. L., H. C. Early, and N. W. Spencer, 1955: A rocket measurement of upper atmosphere density by Paschen's law. Michigan Univ., Scientific Report No. CS-3. AF 19(604)-545, AD 65 396. /R/

614. Spencer, N. W., R. L. Boggess, and D. R. Taeusch, 1964: Seasonal variation of density and temperature over Churchill, Canada, during solar maximum. J. Geophys. Res., 69 (7), 1367-1379.

Atmospheric density and temperature data obtained through application of a technique employing radioactive ionization-gage nose-cone surface-pressure measurements have indicated a seasonal variation of these parameters in the auroral zone at a time of maximum solar activity (1958). A density increase by a factor of 2 to 3 in the summer, centered in the 70- to 80- km region, is observed. Correspondingly, the temperature in the same region decreases and shows much less fine structure than for winter conditions. Density data from nine flights and temperature data for five flights are presented. A previously unpublished temperature profile for White Sands, New Mexico, for the previous solar minimum is presented for comparison.

615. Thiele, Otto W., 1961: Density and pressure profiles derived from meteorological rocket measurements. U.S. Army Signal Missile Support Agency, White Sands Missile Range, Technical Report 108. /R/

616. Thiele, Otto W., 1963: Mesospheric density variability based on recent meteorological rocket measurements. J. Appl. Met., 2 (5), 649-654.

Seasonal and latitudinal variability of density between 30 and 68 km is presented. These data have been derived from direct temperature and height measurements made with meteorological rockets fired at White Sands Missile Range, New Mexico, and Fort Churchill, Canada, during 1960-1962 Meteorological Rocket Network and associated research and development activities. Some of the more significant features are the wider seasonal range at northern latitudes, the absence of significant latitudinal variation during the summer, the greatest variation in the fall and winter at northern latitudes and the overall variation that is indicated in the general region of 50 to 60 km, as much as 50 percent in some cases. The need for both seasonal and latitudinal standard atmospheres where standards are required is clearly demonstrated. Also, the feasibility of providing timely density measurements for direct application is evident.

617. Thiele, Otto W., 1964: Feasibility experiment for measuring atmospheric density through the altitude range of 60 to 100 kilometers over White Sands Missile Range. Internal Report, U.S. Army Electronics Research and Development Activity, White Sands Missile Range, 24 p. AD-450 230.

The experiment involved four soundings utilizing the accelerometer 7-inch falling sphere. All were successful, and data were obtained at altitudes in excess of 100 km in every case. The density data, with the derived temperature and pressure data, are presented. It has been demonstrated that high-altitude atmospheric density measurements can be made in the vicinity of 100 km reliably, and with an estimated maximum error of ± 5 percent. /STAR/

618. Thiele, Otto W., 1964: Some observed short term and diurnal variations of stratospheric density above 30 km. U.S. Army Electronics Research and Development Activity, White Sands Missile Range, ERDA-114, 19 p. AD 432 023.

Some observed variations of atmospheric density between 30 and 65 km over a short time period, including night-day variations, are presented. Five density profiles, three in darkness and two in daylight, were obtained with meteorological sounding rockets over a 48-hour period. The temperature was measured directly with a 0.32 mm bead thermistor, and the atmospheric density was derived using the hypsometric formula. Recent correction techniques have reduced density errors to 2 percent up to 55 km, approximately 2.5 percent from 55 to 60 km, and within 3 percent from 60 to 65 km. Over the altitude range examined, the most significant variations in density occur in the region of 45 to 60 km, which is not surprising since these 5 observations as well as many others show this portion of the stratosphere to be the most active in terms of large temperature changes. Density variations of up to 8 percent were observed at equivalent altitudes over as short a period as 1 hour and 45 minutes from darkness into daylight. In a 24-hour period, variations of as much as 16.5 percent were observed.

619. Van Ornum, D. G., 1963: Investigative study along with design and development of an ultraviolet air density meter. Final Report, Plasmadyne Corp., FR123-427-2184, 77 p. NAS5-427, NAS5-2184, NASA-CR-60002.

This report describes the design, fabrication, and testing of an air density meter based on the measurement of the backscatter of ultraviolet light. It was determined that intermediate ultraviolet near $0.2\,\mu$ was particularly useful for measurements of this kind. Ambient atmospheric density measurements can be made at a position 2 m removed from the detection instruments during daylight, thus avoiding aerodynamic disturbances caused by shock waves, boundary layers, ionization, outgassing, gage aperture velocity vector, and gage chamber temperature. /STAR/

620. Weppner, W. J., 1961: The Air Force ARCAS ROBIN program. In Conference on Status of Meteorological Rocketry, December 5-6, 1961, El Paso, Texas. Conference Program. /R/

621. Wallston, R. A., John E. Masterson, and W. E. Hoehne, 1965: A rocket probe and ground support system for the measurement of density. Paper presented at the 45th Annual Meeting of the American Meteorological Society, Jan. 25, 1965.

A program is being conducted to test the feasibility of a relatively inexpensive vehicle and ground support system for determining atmospheric density between the altitudes of 150,000 and 300,000 ft.

Theoretical considerations and previous experience with the pitot-tube method of measuring density indicate that accuracies of 5 to 10 percent can be achieved. The density probe (DENPRO) vehicle, a SPARROW-ARCAS capable of lifting 14 lb to an altitude of 450,000 ft at the velocity and with the stability required, has been developed.

A capacitance-coupled diaphragm gauge is used to sense the impact pressure. The telemetry system is compatible with the AN/GMD-2 system, both for rocket tracking, which provides altitudes and velocity information, and for data retrieval. The AN/GMD-2 system has been modified to print out angular information more rapidly. The telemetry and ranging data are recorded on magnetic tape.

Preliminary results from two flights have demonstrated the feasibility of the entire system for acquiring density data under operational conditions. The system is flexible enough to be used for gathering other meteorological data.

622. Whipple, Fred L., 1960: Meteors in the measurement of the upper atmosphere. In Source Book in Astronomy, 1900-1950. Shapley, Harlow ed., Harvard Univ. Press, Cambridge, Mass., 82-87.

Atmospheric heights vs. density curves were plotted based on meteor deceleration observations or from the heights at which maximum luminosities occur. The relation of temperature to the logarithm of air density was used for a graph of temperatures versus atmospheric heights. The temperature inversion above 60 km was verified by independent observations of meteor light curves. /MA/

623. Zoike, H., and L. Wohlfahrt, 1961: Ion densitometer for high altitude measurements. Instrument Society of America Fall Instrument-Automation Conference and Exhibit, Los Angeles, California, September 11-15, 1961, 173-LA-61-1. /R/

RADIATION SENSORS

See also: Widger, W.K., Jr., 1963: Meteorological satellites and weather reconnaissance aircraft - complementary observing systems. (175)
Wurtz, H.P., and R.S. Neiswander, 1963: Ground based mapping of upper air winds. (351)

624. Aagard, R. L., 1958: Convection free instrument for measuring infrared radiation in the atmosphere. Rev. Sci. Instr., 29 (11), 1011-1016. /R/

625. Aagard, R. L., 1959: Measurements, by two methods, of the equivalent black-body radiation temperature in the atmosphere. J. Met. 16 (3), 340-343. /R/

626. Aagard, R. L., 1960: Measurements of infrared radiation divergence in the atmosphere with the double-radiometer and the black ball. J. Met., 17 (9), 311-318. /R/

627. Albrecht, H. J., 1957: Transistors as thermometers and bolometers. Geofis. Pura Appl., 37, 191-196. /R/

628. Allison, Lewis J., 1964: An analysis of Tiros II radiation data recorded over New Zealand at night. National Aeronautics and Space Administration, NASA TN D-1910, 17 p.

Infrared radiation measurements in the 8-12μ, 8-30μ, and 6.0-6.5μ wavelength regions taken by Tiros II on its initial orbit over New Zealand are examined in detail. A subjective analysis of the synoptic situation confirmed the two broad-scale frontal systems clearly outlined by the Tiros II radiation data recorded over the Tasman Sea at night. The equivalent blackbody temperatures measured in the 8-12μ region were found to be 6° to 12° K colder than the sea water temperatures in warm radiation source areas. In the 6.0-6.5μ region the equivalent blackbody temperatures, when converted to "effective radiation height," averaged 8705 feet below the tropopause at five upper air stations.

629. Andreychin, R., T. Kekhlibarov, and A. T. Mladenov, 1963: An instrument for the simultaneous recording of the radiation intensity of sunlight in different spectral regions. Izv. Fiz. Inst. ANEB, 11 (1-2), 49-58.

Light from selected regions is isolated by filters and the intensity, measured by photoresistive elements, is electrically recorded. Curves are given showing variation of red, blue and white illumination for three days with no clouds, intermittent clouds and an overcast sky. /PA/

630. Badinov, I. Ya., 1962: Trekhstupenchataia fotoelektricheskaia slediashchaia sistema na tranzistorakh /Three-stage photoelectric tracking system on transistors/. Iskusstennye Sputniki Zemli, No. 14, 74-80.

The follow-up system is designed to be mounted in a container borne by a free aerostat. It is intended for continuous following of the Sun in investigations of direct solar radiation. The structure and operation of the instrument, the electric circuit, diagram of the follow-up system and the characteristics of the electronic system are described. /MA/

631. Bartko, Frank, Virgil Kunde, Clarence Catoe, and Musa Halev, 1964: The Tiros low resolution radiometer. National Aeronautics and Space Administration, NASA TN D-614, 34 p.

The Tiros II, III, and IV meteorological satellite experiments included a low resolution infrared radiometer of broad spectral and spatial response designed to measure the planetary heat budget of the earth. The radiometer consisted of two thermistor detectors each mounted at the base of a reflective cone. One detector was coated black and was sensitive to reflected solar and long-wave terrestrial radiation. The second detector was coated white and was sensitive primarily to the long-wave terrestrial radiation. Simultaneous evaluation of the energy balance equation for each detector yields the earth's apparent blackbody temperature and albedo. The first portion of this paper presents the physical and optical characteristics of the radiometer, the calibration, and the procedure for determining the coefficients of the energy balance equations from the calibration data. The second portion of the paper discusses the procedure for reducing the data and presents an error analysis of the radiation data from a Tiros III orbit. Efforts to improve the performance of the low resolution radiometer and a summary of the status of the low resolution radiometer program are also presented.

632. Boileau, Aimerian R., 1959-1961: Atmospheric optical measurements during high altitude balloon flight, Pt. 1. California Univ., Scripps Institution of Oceanography, Report SIO 59-32-(1), 1959: ... Pt. 2, Sky luminances, Report SIO 61-1, 1961: ... Pt. 3, Sky radiances in the 400 to 500 millimicron region, Report SIO 61-2, 1961. ... Pt. 4, Sky radiances in the 580-700 millimicron region, Report SIO 61-3, 1961, 97 p. NObs-72092, AD 275 261.

Certain optical measurements of the atmosphere were made by the Visibility Laboratory of the Univ. of Calif., San Diego, June 21, 1958 over central Minnesota. Data were recorded from daybreak to mid-morning during the time four balloons carrying optical instrumentation from the Geophysics Research Directorate, Air Force Research Division, Bedford, Mass., were floating at higher altitudes. Pt. I of the report presented the recorded optical measurements, with the exception of sky luminance and radiance distributions, as they varied with altitude, time of day, azimuth with respect to the sun, and meteorological conditions. Part II presented the sky luminance distribution as it varied with altitude, zenith angle, and azimuth with respect to the sun. Pt. III presented similarly the sky radiance distribution as measured by a filter-phototube combination having a spectral sensitivity range of from approximately 400 mμ to approximately 500 mμ. Pt. IV presents in a similar manner the sky radiance distribution as measured by a filter-phototube combination having a spectral sensitivity range of from approximately 580 mμ to approximately 700 mμ.

633. Bolle, Hans-Jürgen, 1962: Untersuchungen der atmospharischen Infrarotstrahlung (7.5-22μ) am Golf von Neapel, I, Die Messapparatur /̅ Investigations of atmospheric infrared radiation (7.5-22μ) on the Gulf of Naples, Pt. I, The measuring apparatus /. Geofis. Pura Appl., 53, 159-170.

A mobile grating spectrometer for infrared atmospheric radiation studies is described. The absolute calibration procedure by means of black bodies is discussed. With regard to the symmetrical optical path mirror and air absorption as well as instrumental temperature have minimal influence on the measurements. /̅MA /

634. Businger, J. A., and P. M. Kuhn, 1960: On the observation of total and net atmospheric radiation. J. Met., 17 (4), 400-405. /̅R /

635. Dana, E. K., R. C. Gelinas, C. W. Jones, L. Mertz, M. J. Persky, G. Wyntjes, and N. O. Young, 1963: Research and development of new techniques and equipment for rocket-borne spectroradiometric systems. Block Associates Inc., 76 p. AF 19(604)8016, AFCRL-63-249.

This review of work directed toward the development and testing of new techniques, instrumentation, and applications for rocketborne spectroradiometric systems includes: (1) the design of two-dimensional data transform systems; (2) the evaluation and improvement of electronic components; (3) research on pulse biasing of detectors; (4) the evaluation and improvement of transverter power supplies; (5) an analysis of the effects of source modulation on performance of radiometric systems with special emphasis on interferometer spectrometers; (6) the design of a logarithmic amplifier; (7) the design and evaluation of internal calibration sources for spectroradiometers; and (8) a study of the characteristics, limitations, and possible application of the "E" series instruments, which include the E-2E radiometer and the E-6 and E-8 spectroradiometers. /̅STAR /

636. Deam, A. P., 1962: Radiosonde for atmospheric refractive index measurements. Rev. Sci. Instr., 33 (4), 438-441.

Detailed description of a reliable, light-weight and inexpensive instrument to sample the atmosphere with a resonant cavity nominally resonant at 403 Mc/s, extendable to higher frequencies, and capable of providing remote information. The radiosonde shown photographically and in a circuit diagram has been tested; two profiles are given. The instrument is also successfully usable in polarization studies, electron density measurements, etc. /̅MA /

637. Drummond, A. J., 1961: Current developments in pyrheliometric techniques. Solar En., 5 (1), 19-23.

A review is presented of the principal objectives and problems associated with the measurement of the different components of solar radiation. The new universally accepted pyrheliometric standard of reference is discussed as are the more important instrumental requirements for local reproduction, with high precision, of this international standard. Attention is directed towards the accuracy now attainable in integral and spectral wavelength radiation measurements, which is assuming increasing significance in view of the satellite, missile and other upper atmospheric projects currently in focus.

638. Drummond, A. J., 1963: Examination of the characteristics of pyrheliometers used to establish standard scales of solar radiometry and the development of improved instrumentation. Final Report, Eppley Lab., Inc., 11 p. AF 19(604)-8339, AFCRL-63-887.

The main results of a trial field test program conducted at a high-altitude location are presented and the conclusion drawn that to determine, precisely and accurately, differences in radiative flux density arising from varying the acceptance aperture of a solar pyrheliometer, a new design of instrument is called for. The development of such an improved pyrheliometer is described, as is also the associated readout instrumentation.

639. Dutton, John A., 1962: Space and time response of airborne radiation sensors for the measurement of ground variables. J. Geophys. Res., 67 (1), 195-205.

Mathematical relationships between true values of ground variables and values recorded by radiation-sensitive instruments mounted on an airplane in horizontal flight are given. Both temporal and spatial distortions are considered; atmospheric depletion is not. Instruments now in use on an airplane are described to provide specific illustrations. It is shown that measurement of space averages is possible, and weighting functions which affect the recorded values are exhibited for both narrow- and wide-beam instruments. A tractable analysis of the characteristics of wide-beam instruments requires assumptions about the homogeneity or antisymmetry of the ground variable. Measurement of variations in small areas is shown to be difficult with standard instruments. Weighting functions are derived

which allow reconstruction of the variance and cross spectra of ground values from the spectra of the recorded values. The development suggests important factors in flight planning and yields methods of error analysis.

640. Edwards, H. D., A. Goddard, Jr., M. Juza, T. Maher, and F. Speck, 1956: Balloon-borne system for tracking the sun. Rev. Sci. Instr., 27 (6), 381-385. /R/

641. Eisele, R. E., 1960: Radiation measurements with the R-W radiometer-gradient meter. Air Force Cambridge Res. Lab., GRD Res. Notes, No. 46, 212-240.

The measurement program scheduled by the Ramo-Wooldridge Corporation involved the use of the radiometer-gradient meter in a series of measurements from sea level to 10,000 ft or more a.s.l. This paper contains the results of observations made in the Colorado Springs area and includes a description of the basic instrumentation. Detailed description of the design of the radiometer-gradient meter and its instrumentation will be found in the reports listed in the appended bibliography.

642. Fenn, F. W., and H. K. Weickmann, 1960: Atmospheric net-radiation flux during winter in the Thule area, Greenland. U.S. Army Signal Research and Development Laboratory, USASRDL TR-2090. (See also: J. Geophys. Res., 65 (11), 3651-3656, (1960).) /R/

643. Fritschen, L. J., and W. R. Van Wijk, 1959: Use of an economical thermal transducer as a net radiometer. Bull. Am. Met. Soc., 40 (6), 291-294. /R/

644. Fritschen, L. J., 1960: Construction and calibration details of the thermal-transducer-type net radiometer. Bull. Am. Met. Soc., 41 (4), 180-183. /R/

645. Fritz, S., P. Krishna Rao, and M. Weinstein, 1964: Satellite measurements of reflected solar energy and the energy received at the ground. J. Atmospheric Sci., 21 (2), 141-151.

A method is described for comparing satellite measurements of reflected solar radiation with pyrheliometric measurements at the ground and with measurements from airplanes. When data from accurate, well-calibrated satellite instruments become available, this method can be used to compute the solar energy absorbed directly in the atmosphere. In the meantime the method is applied to solar radiation measurements from Tiros III, although these data are of doubtful accuracy. Tiros III measured the solar energy reflected by the planet Earth. Several of these measurements, taken over the United States near noon on 12 July 1963 are described. The corresponding "albedos" which varied from 0. 65 over a bright overcast area to 0. 05 over some cloudless areas, may be too low. The reflected energy is correlated with pyrheliometer measurements at the ground at 31 stations. The correlation coefficient was -0. 9. The relationship between the satellite measurement and the ground pyrheliometer measurements is further compared with similar measurements made from airplanes in previous years. It is this comparison which suggests that the satellite measurements of albedo may be too low. From the satellite measurements and the ground pyrheliometer measurements, the solar energy absorbed by the atmosphere itself can be computed after reasonable assumptions about the ground albedo are made. These absorptions sometimes exceed 35% of the solar energy entering the top of the atmosphere; the values appear to be too large and are a consequence of the relatively low satellite values of measured reflectivity over cloudy areas. / PA /

646. Funk, J. P., 1960: Transient response of net radiometers. Arch. Met. Geophys. Bioklimatol., B, 10 (2), 228-231.

The response of a net radiometer to a sudden irradiation is shown to give generally a marked overshoot which during calibration is mostly overlooked. This overshoot also simulates a high speed of response. An improved design of net radiometer minimizes this effect and also gives a high sensitivity.

647. Fuquay, Don, and Konrad Buettner, 1957: Laboratory investigation of some characteristics of the Eppley pyrheliometer. Trans. Am. Geophys. Union, 38 (1), 38-43.

The pyranometer of Eppley shows the following deviations of its scale value: (1) The temperature coefficient consists of coefficients of the thermopile and of the different heat exchange parameters. (2) Air convection within the glass bulb causes a dependency of the scale value on the angle between the receiving surface and the direction of gravity. (3) Rays from below the instrument plane may be reflected by the glass ball onto the receiving surface. (4) The existing black paint has a specular reflection which causes a dependency on the angle of incidence. All deviations can be brought under control by suitable modification or calibration.

648. Gates, D. M., D. G. Murcray, C. C. Shaw, and R. J. Herbold, 1958: Near infrared solar radiation measurements by balloon to an altitude of 100,000 feet. J. Opt. Soc. Am., 48, 1010-1016. /R/

649. Gergen, J. L., 1956: "Black ball": a device for measuring atmospheric infrared radiation. Rev. Sci. Instr., 27 (7), 453-460. /R/

650. Goddard, Alfred A., Jr., 1963: Report of sky luminance and solar luminance data from solar tendem balloon flights May 17, 1962. Sci. Report No. 1, Hi-Altitude Instrument Co., Inc. AF 19(604)-7472, AFCRL-63-617.

The results of two balloon flights, 50 min apart, to obtain solar and near-sun sky luminance data as a function of altitude are given. Luminances as a function of time are also given for both flights at the float altitude of 84,000 ft. These data were obtained in the broad spectral region from 400-800 mμ using CdS detectors.

651. Goldberg, I. L., 1961: Radiation from planet earth. U.S. Army Signal Research and Development Laboratory, USASRDL TR-2231. AD 266 790. /R/

652. Gondet, M. H., 1963: Current knowledge of solar and terrestrial radiation. J. Rech. Cent. Nat. Rech. Sci., No. 64, 317-329.

A summary of current knowledge of solar radiation and its effect on the earth, including discussion of the temperature of the different regions of the solar atmosphere, the amount of solar energy received both above and below the earth's atmosphere, and the distribution of this energy over the earth. Brief descriptions of the types of apparatus normally used in this work are given. /PA/

653. Goody, R. M., and G. D. Robinson, 1951: Radiation in the troposphere and lower stratosphere. Quart. J. Roy. Met. Soc., 77 (332), 151-187. / R /

654. Griggs, M., and A. E. S. Green, 1963: Calculations of the transmission of the atmosphere in the infrared. Infrared Phys., 3 (3), 181.

Howard and Garing quoted the results of atmospheric transmission in the infrared at 2.7μ by six different methods and their varying values. It is suggested that much of the disagreement was due to the different water-vapour distribution models being used. Results are given for the mean transmission over the band 2.66-2.74μ excluding scattering effects through the 1959 ARDC model atmosphere using uniform CO_2 concentration by volume of 0.032% and the standard water vapour model prepared by Gutnick. The observer is at 12 km altitude looking at 70° to the vertical right through the atmosphere. This method for calculating the slant path transmission accomodates almost any water vapour distribution without numerical or graphical calculations. / PA /

655. Gul'nitskiy, L. V., and I. I. Maslennikov, 1964: An actinometric station composed of absolute instruments. In Actinometry, Atmospheric Optics, and Nuclear Meteorology. National Aeronautics and Space Administration, NASA TT F-150, 15-23.

Many years of research into the problem of improving the methods of actinometric observation and devising a common actinometric scale, coupled with experience in the design of a series of actinometric instruments, have led to the construction of an actinometric station composed of 36 absolute instruments, operated by a team of scientists who designed, built, and tested these instruments. Some of these instruments are pyrhelio-pyrgeometer, compensation pyrgeometer, effective pyranometer, balance indicator, and compensation pyranometer. / STAR /

656. Hanel, R. A., 1960: The dielectric bolometer, a new type of thermal radiation detector. National Aeronautics and Space Administration, NASA TN D-500, 10 p.

Thermal detectors for the infrared, such as thermocouples and bolometers, are limited in their ultimate sensitivity predominantly by Johnson noise rather than temperature noise. Low noise figures are hard to achieve since Johnson noise preponderates temperature noise, which is the only essential noise for thermal detectors. The dielectric constants of some materials are sufficiently temperature dependent ot make a new type of bolometer feasible. The basic theory of a dielectric bolometer, as shown here, promises noise figures below 3 decibels even at chopper frequencies well above the $1/\tau$ value of the detector. Ferroelectrics such as barium-strontium titanate and others seem to be well suited for radiation-cooled dielectric bolometers.

657. Hanel, R. A., and D. Q. Wark, 1963: Physical measurements for meteorological satellites. Astronautics and Aerospace Eng., 1, 85-88.

A review of physical measurements from meteorological satellites underway or planned for the near future. One involves indirect determination of the atmospheric temperature. The most feasible instrument would be an infrared grating spectrometer with multiple detectors. Another area of interest is microwave radiometry. The distribution of ozone might also be found from measurements in the strong Hartley band in the ultraviolet. Measurements of reflected sunlight by a satellite instrument can indicate the prescence of a cloud but height of cloud tops must be known. Infrared radiometric measurements can be used to determine cloud-top temperatures, but the relation between height (or pressure) and temperature in the atmosphere is highly variable. Another method independent of temperature variation is suggested. One experiment would deal with the solar constant. Another involves the measurement of "sferics" or the RF emissions by lightning.

658. Hanson, Kirby J., and Herbert J. Viebrock, 1964: Albedo measurements over the northeastern United States. Mon. Wea. Rev., 92 (5), 223-234.

On September 16, 1961, Eppley pyranometers mounted in a P2V-7 aircraft were used to measure the incoming and outgoing solar radiation fluxes at 7,500, 9,500 and 25,000 ft. along flight paths between Atlantic City, N. J., and Erie, Pa. Albedo values are determined from this information for the flight level. Simultaneous photographs and radiation values were obtained on the 25,000-ft. flight. The albedo for the high-level flight varied from 0.158 for no undercast to 0.538 for a complete altocumulus undercast. Two selected observations at 1722 GMT and 1737 GMT are further discussed. A solar radiation budget is prepared for the 1737 GMT measurement using the high-level flight data and ground data from Thornthwaite Laboratories near Elmer, N. J.

659. Houghton, J. T., and A. W. Brewer, 1954: A new radiometer. J. Sci. Instr., 31, 184-187. /R/

660. Howard, J. N., and J. S. Garing, 1962: Transmission of the atmosphere in the infrared. Air Force Cambridge Res. Labs., Air Force Surveys in Geophysics No. 150, 24 p. AFCRL-62-814.

In a previous paper, an attempt was made to review and summarize our knowledge of infrared atmospheric transmission as of mid-1959. The present survey discusses the work that has been done in the past two or three years. Both the theoretical and experimental efforts are covered, with some emphasis on techniques developed to calculate the slant-path transmission.

661. Johnson, D. S., D. L. Fain, R. L. Hershey, and D. S. Stacey, 1961: Design study for an improved operational radiometer. Final Report, Ball Brothers Research Corporation. AF 19(604)-6121, AD 267 935. /R/

662. Kahl Scientific Co.: Radiationsonde No. 17M-02. Technical Bulletin No. 17M, Kahl Scientific Co. /R/

663. Kahl Scientific Co.: Radiationsonde No. 17M-06. Technical Bulletin No. 17M, Kahl Scientific Co. /R/

664. Kasatkin, A. M., 1963: Upper-level optical station for investigations of the atmosphere. Iskusstvennye Sputniki Zemli, No. 15, 3-21.

The technical specifications and capabilities of the VGAS (Upper Level Geophysical Automatic Station), used for optical investigations of the atmosphere, are described. The "station" is a rocket-launched 360 kg, 1-meter diameter sphere. A 20-kg equatorially mounted gyroscope orients the sphere in space between the levels of 65 to 100 km during ascent and from 100 to 43 km during descent. The gyroscope used in connection with the sun-position sensor defines the station's position in space. The station is equipped with seven optical devices: telephotometers, teleradiometers, telespectrometers, spectroanalyzers, balance meters (net radiometers), actinometers, and control devices which determine the position of the station. The VGAS may be used to investigate upper-level radiation parameters and to obtain statistical

data on the distribution of longwave and shortwave radiation intensity over the earth and data on the atmospheric radiation balance. It may also be used to determine the temperature of the underlying surface, the height of the tops of clouds, the amounts of ozone, water vapor, and meteoric matter in the atmosphere. /AID/

665. Kellogg, William W., 1960: Upper atmosphere studies. Trans. Am. Geophys. Union, 41 (2), 179-183.

Progress in upper atmosphere research in the past 3 years is briefly outlined. The exploration of various regions of atmosphere by balloons and by rocket has been actively pursued. There are two areas in which the advances have been particularly spectacular. These are, first, the forgotten region between the ceiling of the balloon network and the ionosphere, and the radiation environment of the Earth and its effects on the upper atmosphere. /MA/

666. Kondrat'yev, K. Ya., 1961: Soviet investigation in actinometry and atmospheric optics. Weather, 16 (6), 180-186.

The development of research over the last ten years is reviewed. New thermoelectric actinometers, pyranometers and balance meters were developed for the IGY during which 200 stations were operating in U.S.S.R. territory. Using data and theoretical considerations an atlas of heat balance has been prepared (Budyko, 1956). In the study of the local radiation regime progress has been made on the role of dust in the absorption solar radiation and on the radiative properties of different types of natural surfaces. The problems of spectral transparency and visibility in different meteorological conditions are being studied. Research on the day sky brightness has been chiefly aimed at the determination of the atmospheric scattering function. The optical investigation of atmospheric aerosols has attracted great attention both in the laboratory and under natural conditions. Theoretical investigations of radiation transfer have covered such subjects as; the theory of light scattering by separate particles, problems of multiple-scattering, radiation transfer in a turbid medium, infrared radiation transfer and so on. Three general conferences on the problems of actinometry and atmospheric optics have taken place during the past five years. /MA/

667. Kondrat'yev, K. Ya., 1964: On the possibility of the direct measurement of radiative divergence. In Probl. of the Phys. of the Atmosphere, Collection I. National Aeronautics and Space Administration, NASA TT F-184, 1-25.

The problem of determining the radiative divergence and, in particular, its effect on the thermal regime and dynamics of the atmosphere, is discussed. In order to devise a method for direct measurement of the radiative divergence at different levels in the free atmosphere at night, Gergen proposed that the difference between the temperature of the air and that of a black ball might serve as a characteristic of its magnitude and sign. Gergen's theory and equations are discussed. /STAR/

668. Kondrat'yev, K. Ya., Z. F. Mironova, A. N. Otto, et al., 1962: Spektral'noe al'bedo nekotorykh podstilaiushchikh poverkhnostei v vidimoi i blizkoi infrakrasnoi oblastiakh spektra /Spectral albedo of some surfaces in the visible and near infrared regions of the spectrum/. Geologijos ir Geografijos Institutas, Mokslíniai Pranesimai, 13, 167-173.

The construction and operation of an improved spectrophotometer for measuring albedo in the 400-1000 mμ region of the spectrum is described. The device is based upon the serial universal UM-2 monochromator. The individual components of the device include the following: a spherical photometer, a monochromator, a photoelectric amplifier FEU-22, a constant current amplifier, an electronic potentiometer and a control panel. The construction of the spectrophotometer is described with the aid of a block diagram and a current diagram of the constant current amplifier. Also the construction of an infrared spectrometer for measuring albedo is described with the aid of a block diagram and the optical arrangement of the monochromator. The results of measurements of the daily variation of the spectral albedo of dry grass, green grass and fresh snow are presented in graphs. /MA/

669. Kondrat'yev, K. Ya., G. N. Gayevskaya, G. A. Nikol'skiy, 1964: Experimental investigations of the radiation balance in the free atmosphere. In Probl. of the Phys. of the Atmosphere, Collection I. National Aeronautics and Space Administration, NASA TT F-184, 26-86.

Investigations of the vertical profile of the radiation balance and its components, and the related problems of the radiation balance of the earth's surface atmosphere (the macro-albedo of the underlying surface, etc.) are discussed. Included are descriptions of the following: (1) the standard actinometric apparatus, (2) actinometric radiosondes, and (3) special apparatus for balloon and aircraft measurements-pyranometers, cloud photorecorders, radiometers, etc. /STAR/

670. Kostianoi, G. N., 1963: Aktinometricheskii radiozond /Actinometric radiosonde/. Met. i Gidrologiia, 7, 47-49.

A new type of actinometer for upper air soundings has been developed at the Central Geophysical Obs. The recording part of the instrument is shaped like a drum with a diameter of 120 mm and a depth 30 mm. The outer ring of the drum is made of a blackened material. Just within this outer ring is a second inner ring which adds rigidity while at the same time preventing too much heat from the outer ring from affecting the temperature of the inner part of the instrument. Across the outer flat surfaces of the drum are stretched diaphragms of sensing material, and thermocouples in the center of these diapragms measure their temperature. Between these two reflecting surfaces and parallel to them, are placed 3 layers of aluminum foil. The whole apparatus is covered with a palstic cover so that the pressure on the sensing surfaces remains constant. The actinometer and the associated radio transmitting equipment are carried aloft by balloon, the actinometer itself being a distance of about 30 m below the balloon with its receiving surfaces horizontal. The basic principles underlying the interpretation of the temperature readings is described. In surface conditions the instrument was found to be accurate to within 10%. /MA/

671. Kuhn, P. M., 1961: Accuracy of the airborne economical radiometer. Mon. Wea. Rev., 89 (8), 285-287.

Further data are presented to indicate the accuracy of the airborne economical radiometer (frequently termed radiometersonde when used in a modified radiosonde system) in the measurement of infrared radiation, in view of its recent widespread use. Three aspects are discussed. The first deals with a nocturnal ground comparison of the economical radiometer with a Suomi ventilated radiometer. The second covers an analysis of random errors in the net radiation obtained with the economical radiometer in the radiometersonde system. And, finally, an experimental in-flight verification of the correctness of the conductivity term in the equations for the economical radiometer is discussed.

672. Kuhn, P. M., and V. E. Suomi, 1958: Airborne observations of albedo with a beam reflector. J. Met., 15 (2), 172-174. /R/

673. Kuh, P. M., V. E. Suomi, and G. L. Darkow, 1959: Soundings of terrestrial radiation flux over Wisconsin. Mon. Wea. Rev., 87 (4), 129-135. /R/

674. Kulkarni, P. V., and J. C. Barnes, 1964: Nocintograph. Can. J. Phys., 42 (1), 1-14.

A new instrument called a nocintograph (nocturnal intensity recorder) is described. This instrument scans the entire dome of the sky and records the intensities of the night sky radiations in four wavelengths several times during a night according to a predetermined program. Test records obtained on this instrument are presented and briefly discussed. /PA/

675. Larsen, S. H. H., T. Fujita, W. L. Fletcher, 1963: TIROS III measurements of terrestrial radiation and reflected and scattered solar radiation. Chicago Univ., Research Paper No. 20, 11 p. NASA NsG 333, AD 428 161.

The distribution of outgoing terrestrial radiation within the 8- to 12- micron band, over North Africa, is presented together with the pattern of reflected solar radiation. The analyses are based on data from analog traces of the five-channel medium resolution scanning radiometer on TIROS III. The data which have been used are obtained from measurements made under conditions favorable to the angular resolution of the radiometer, which changes as the satellite spins and progresses along its path; and a pattern of differential heating over the desert area was observed.

Calculations of the rate of reflectance over the Sahara desert have been made and the values obtained over the sand dunes, about 23 percent, appear to be realistic. These radiation data have also been used in a study of the anisotropic nature of scattered radiation; the results of this approach indicate the ability of the satellite to give valuable measurements in the study of scattering properties of the atmosphere.

676. Latimer, J. R., 1964: An integrating sphere for pyranometer calibration. J. Appl. Met., 3 (3), 323-326.

An integrating sphere which can be used to calibrate pyranometers such as the Eppley pyrheliometer (180° Weather Bureau type) is described. The integrating sphere makes it possible for one man to calibrate a dozen or more pyranometers in a day against a standard. Experience to date has shown that the calibration is reproducible to better than 0.5 percent.

677. Marchgraber, Reinhold M., and Ralph W. Armstrong, 1962: Solar radiation measurement instrumentation. U.S. Army Signal Research and Development Laboratory, USASRDL TR-2251.

A pyranometer for measuring sun and sky radiation on a horizontal surface in selected broad spectral bands has been developed by the Eppley Laboratory and the Signal Corps along lines suggested by, but differing materially from, an equipment for this purpose furnished some years ago by the Smithsonian Astrophysical Observatory to the Quartermaster Corps at Fort Lee, Va. The Eppley Laboratory substantially modified its thermoelectric-type sensor to permit use of hemispheric glass filters of practical size. Desired spectral bands can be selected by using two or more units with differing sharp cut-offs on the ultraviolet side of their pass bands, but nearly identical transmission limits on the infrared side; and subtracting the output of the narrower bands from the longer. The new equipment is described and its design philosophy and performance are discussed. A mount providing for altitude and azimuth adjustments, and provision for as many as three different hemispheric filters on each sensing unit, make the equipment suitable for a variety of applications.

678. Möller, Fritz, and Ehrhard Raschke, 1964: Evaluation of TIROS III radiation data. Munich Univ., NASA CR-112, 114 p.

A method for the determination of the mean relative humidity of the troposphere and of the surface temperature of clouds or of the ground from radiation data of the TIROS III meteorological satellite is discussed. The errors arising from the assumption of model conditions for the atmosphere have been estimated.

This method has been tested with radiation data measured during orbit 61 above the Atlantic Ocean. The results are represented in maps. Surface temperatures determined from measured values above cloudless regions are 8° - 9°C lower than the actual surface temperatures. From the geographical distribution of the relative humidity of the troposphere, the large scale circulation patterns of atmosphere (ascending air in the inner tropical convergence zone and descending air in the subtropical belts) can be recovered.

By statistical investigations the correlation between the radiation data of all 5 channels has been investigated. The results however are strongly influenced by the meteorological conditions being present during the time of measurements. Thus some correlations are only apparent ones.

679. Müller, Hans Gerhard, 1961: Eine Radiosonde zur Messung der kurzwelligen Strahlung und der Albedo in der freien Atmosphäre /A radiosonde for measurement of short wave radiation and albedo in the free atmosphere/. Beiträge zur Physik der Atmosphäre, 34 (1/2), 35-52.

A radiosonde measuring the shortwave radiation in the free atmosphere by means of phototubes is described. Some examples of performed ascents are given and results discussed. The absorption of radiation (effective wavelength about 780 mμ) is found between 3.3 and 14%/km. Extinction coefficients of diffuse radiation in clouds increase with height according to the distribution of the content of condensed water and size of cloud particles. /MA/

680. Murcray, D. G., 1961: Infrared atmospheric transmittance and flux measurements. Six-Month Technical Report No. 2, Denver Univ. AF 19(604)-7429, AD 262 963. /R/

681. Murcray, D. G., 1963: The University of Denver high-altitude infrared background investigation. In Symp. on Background Radiation (Ultraviolet, Visible and Infrared Levels and Distributions). Chicago Univ., 86-94.

A brief description is given of the balloon-borne radiometer system that has been constructed to make measurements of the infrared background of the earth. For the initial measurements, the radiometer was equipped with a thermistor bolometer detector and filters with various spectral band passes in the region from 1μ to 30μ. Recently the radiometer system has been modified, and the thermistor bolometer replaced by a cooled InSb detector. The filters have been replaced with filters of various spectral bandwidth centered around 2.7μ and 4.3μ atmospheric absorption bands. The modified radiometer system has been flown a number of times this spring, and some preliminary results obtained on these flights are presented. These indicate that high spectral radiances can be observed in the 2.7μ region even on "clear" days. These high radiances appear to be the result of forward scattering of the solar radiation. /STAR/

682. Murcray, D. G., J. N. Brooks, F. H. Murcray, W. J. Williams, and F. E. Leslie, 1960: Instrumentation for balloon-borne infrared-spectral transmission measurements of the atmosphere. Scientific Report No. 3, Denver Univ. AF 19(604)-2069, AD 236 976. /R/

683. Murcray, D. G., J. N. Brooks, N. J. Sible, et al., 1962: Optical measurements from high altitude balloons. Appl. Opt., 1 (2), 121-123.

A description is given of a system that has been constructed to make radiometric measurements from high altitude balloons. The instrumentation consists of a 20-cm aperture, 30-cm focal length radiometer that has been equipped to scan in azimuth and elevation, a filter system so that spectral data can be obtained, an onboard digital magnetic tape recording system for recording the data generated during the flight, auxiliary electronics and power supplies for operation of the equipment, and a gondola to serve as a suitable scanning platform and to protect the equipment when it is returned to the ground by parachute at the end of the flight. The results obtained on a balloon flight made with this equipment on May 8, 1959 are also presented. For this flight the radiometer was equipped with a thermistor bolometer detector with a KRS-5 window and with filters that transmitted radiation from 1μ to 2μ, 2μ to 3μ, 3μ to 5μ, 5μ to 8μ, and 8μ to 35μ. These results are presented in the form of isoradiance plots. /MA/

684. Murcray, D. G., F. H. Murcray, and W. J. Williams, 1964: Variation of the infrared solar spectrum between 2800 and 5100 cm^{-1} with altitude. J. Opt. Soc. Am., 54 (1), 23-27.

A prism spectrometer capable of scanning the region from 2800 to 5100 cm^{-1} was flown on a balloon in conjunction with a biaxial pointing control. Spectra were obtained at various altitudes up to 23 km from the ground. These data are presented in this report. The experimental results are compared with the spectra calculated using results given by Zachor. The total absorptances are also compared with theoretical values predicted using a procedure suggested by Plass and with the laboratory results of Howard, Burch, and Williams. /PA/

685. Newkirk, G. A., and J. A. Eddy, 1962: Daytime sky radiance from forty to eighty thousand feet. Nature, London, 194 (4829), 638-641.

The High Altitude Observatory has flown an externally occulting coronograph up to heights of 82,000 ft to measure the angular and the wavelength distribution of the daylight sky. The balloon-borne instrument was pointed at the center of the solar disc to within an accuracy of ±1 min of arc by guiding gimbals. Photographic records were obtained at scattering angles of φ = 9.6°, 20.7°, 31.4°, 40.6° and 57.8° at λ = 0.44 μ and from φ = 1.67 to 2.8° at $\lambda\lambda$ 0.37 - 0.79 μ and photoelectric records were made for φ = 10.3° at λ = 0.52 μ. The results from a flight made on Oct. 3, 1960 are published here and a brief comparison is made with sky radiances which might be expected from a pure, molecular sky at 180,000 ft. /MA/

686. Oetjen, Robert A., Ely E. Bell, James Young, et al., 1960: Spectral radiance of sky and terrain at wavelengths between 1 and 20 microns, Pt. 1, Instrumentation. J. Opt. Soc. Am., 50, 1308-1313.

A description is given of a mobile laboratory equipped with two spectrographs for radiance measurements of the sky and terrain between 1 and 20 μ. The laboratory has its own ac power supply and means for controlling its temperature. Procedures are described for calibrating the instrumentation and transforming the data into spectral radiance (in μ-watts cm^{-2} sterad.$^{-4}$ μ^{-1}) as a function of wave length.

687. Parker, Robert, 1963: Transistorized radiometers and high altitude radiation measurements. Final Report, Jan. 1960 - Dec. 1962, Colorado Univ. AF 19(604)-7240.

This report describes three types of electronic-optic equipment packages built by the Univ. of Colorado under the above cited contract and its predecessor AF 19(604)-1899 for measurement of earth and solar radiation. One type is a miniature, electronic, bolometer-detector type with either optics-selector turret or optics spatial-scanner head. This type was designed to measure either the albedo of the earth or the self-emission of the earth from a satellite. Fourteen of these radiometers were flown by the Lockheed Missile Systems Center on 7 satellites. The results of these flights are included in this report. A second type, much bulkier than the first but functionally the same, was designed to measure the solar constant from an Aerobee rocket fitted with a biaxial pointing control. This type and the results of the second of two flights are discussed. The third type is an interfermetric spectrometer, only one of which has been built. It was intended for use in a sub-orbital rocket flight study of the 6300 Å oxygen airglow spectral line to determine the intensity and doppler width variation with altitude. A brief description of the instrument is given.

688. **Pohl, W.**, 1956: Messungen des ultraroten Strahlungsstromes in der freien atmosphäre. Z. Geophys., 22 (1), 1-52. /R/

689. **Reemann, Yu.**, 1960: Ob integrirovanii priamoĭ solnechnoĭ radiatsii pri pomoshchi induktsionnogo schetchika /Measurement of direct solar radiation by means of an automatic integrator/. Eesti NSV Teaduste Akadeemia. Füüsika ja Astronoomia Instıtut, Uurimusi Atmosfäärifüüsikast, 2, 172-180.

An automatic radiation integrator based on a compensograph is described. The counter of alternating current guided by a special transformer acts as an integrating mechanism. The maximum error of the apparatus is found to be ±2%. Theoretical calculations are given to determine the errors of integration caused by inertia of the measuring instruments. The hourly totals from the integrator are compared with those from a recording millivoltmeter. It was found, taking 15 readings per hour from the autograph, that the root-mean square difference between the hourly totals obtained by these two different methods is 1.1 ly with the sky nearly clear and 3.3 ly in the case of variable cloudiness. /MA/

690. **Ross, Yu.**, 1960: Opyt primeneniia elektronnykh potentsiometrov v aktinometrii /Experience in using recording potentiometers in actinometry/. Eesti NSV Teaduste Akadeemia. Füüsika ja Astronoomia Institut, Uurimusi Atmosfäärifüüsikast, 2, 164-171.

The possibilities of using recording potentiometers in actinometry for the continuous recording of the radiation balance components are considered. It was found that for the purpose of recording the total incoming radiation from the sun and the sky, diffuse sky radiation and the radiation reflected by the surface, the best recording potentiometers were those of type ∋ IIII-09 with whole range variation altered to the 2-3 mv full-scale. For the recording of radiation balance B-S' a recording potentiometer of type ∋ IIII-06 can be used. The recording of the direct solar radiation with a recording potentiometer is ineffective, a recording galvanometer of type MCIIIIIp being better suited for this purpose. /MA/

691. **Stuart, F. E.**, 1958: A miniature transistorized radiometer for measurement of visible and infrared radiation from high altitude vehicles. Scientific Report No. 1, Colorado Univ. AF 19(604)-1899, AFCRC TN-58-610, AD 209 220. /R/

692. Suomi, V. E., and P. M. Kuhn, 1958: An economical net radiometer. Tellus, 10 (1), 160-163. /̲R̲/

693. Suomi, V. E., D. O. Staley, and P. M Kuhn, 1958: A direct measurement of infrared radiation divergence to 160 mb. Quart. J. Roy. Met. Soc., 84 (360), 134-141; discussion: Quart. J. Roy. Met. Soc., 84 (362), 472. /̲R̲/

694. Swinbank, W. C., 1963: Long-wave radiation from clear skies. Quart. J. Roy. Met. Soc., 89 (381), 339-348.

Analysis of the observations of long-wave radiation from clear skies, R, made by Dines at Benson, yields a correlation coefficient of 0.99 between R and the black-body radiation at the corresponding screen temperature T. A new series of measurements over wider ranges of temperature and humidity confirms this, with the same value for the correlation between R and σT^4, the regression equation being: $R = -17.09 + 1.195\ \sigma T^4$ (milliwatt cm^{-2}, T °K). An alternative representation of equal accuracy is $R = 5.31.\ 10^{-14}\ T^6$ (milliwatt cm^{-2}, T °K). The latter formulation is probably better founded physically, and brings out the temperature dependence of the "effective emissivity" ϵ (i.e. $R/\sigma T^4$), which the atmosphere must exhibit. Either expression provides an estimate of R in terms of T with a probable error less than 0.5 mw cm^{-2}. The analysis omits any explicit reference to the influence of vapour pressure e on R, and so differes essentially from those due to Brunt and Angström. Re-appraisal of these latter suggests that the relationships established therein between ϵ and e result basically from a correlation between temperature and humidity. Both the nature and the degree of the correlation between ϵ and e for a given locality would then depend on the temperature-humidity regime occurring there. The wide variations from place to place, both in the values of the coefficients occurring in the Brunt and Angström equations, and in the degree of correlation found between $R/\sigma T^4$ and the corresponding function of e, are thereby explained. /̲PA̲/

695. Tanner, C. B., J. A. Businger, and P. M. Kuhn, 1960: The economical net radiometer. J. Geophys. Res., 65 (11), 3657-3667. /̲R̲/

696. Tardif, J. A., 1964: Energy and wavelength calibration of a balloon-borne spectrometer for infrared background measurements (Gondola V). Canadian Armament Research and Development Establishment, Valcartier (Quebec).

The spectral radiance response at simulated altitudes of 40,000 feet and 93,000 feet was obtained for the Gondola V grating spectrometer equipped with a gold-doped germanium detector. A wavelength calibration was also made for wavelengths between 3.4 and 8.5 microns.

697. Theisen, John F., 1961: Direct measurement of refractive index by radiosonde. Bull. Am. Met. Soc., 42 (4), 282.

A brief letter comparing the system used by Clinger and Straiton with the system used by the U. S. Navy Electronics Laboratory at San Diego, California. A schematic diagram of the Navy Electronics Lab. system is shown. It has the advantage of using standard radiosonde transmitters and receivers and merely adding a simple analog computer at the receiver installation on the ground. Wet and dry bulb temperatures are measured separately and displayed on recorders as an aid in interpreting the refractive index record and to improve the computed pressure-altitudes. [MA]

698. Theisen, John F., and Earl E. Gossard, 1961: Free-balloon borne meteorological refractometer. J. Res. NBS, 65 (2), 149-154.

In this paper a free-balloon borne refractometer is described and samples of soundings are shown. The instrument has been used for sampling the refractive index through the troposphere in a study of the fine structure of refractive layers over Southern California. It uses fast response temperature and humidity elements and is carried aloft by a standard radiosonde balloon. The instrument avoids the defects of the usual radiosonde for obtaining refractive index information while allowing a nearly vertical sounding to be obtained without the disturbance of the atmosphere characteristic of a sounding taken by an aircraft. [MA]

DISTRIBUTION LIST

Addressee	No. Copies
Defense Documentation Center ATTN: TISIA Cameron Station (Bldg 5) Alexandria, Virginia 22314	20
Director U. S. Naval Research Laboratory ATTN: CODE 2027 Washington, D. C. 20390	1
Commanding Officer and Director U. S. Navy Electronics Laboratory ATTN: Library San Diego, California 92101	1
Air Force Cambridge Research Laboratories ATTN: CRXL-R L. G. Hanscom Field Bedford, Massachusetts 01731	2
Commanding General U. S. Army Electronics Proving Ground ATTN: Technical Library Fort Huachuca, Arizona 85613	1
Commanding General U. S. Army Electronics Command ATTN: AMSEL-RD-DR Fort Monmouth, New Jersey 07703	1
Commanding General U. S. Electronics Command ATTN: AMSEL-RD-ADO-RHA Fort Monmouth, New Jersey 07703	1
Commanding Officer U. S. Army Electronics R & D Activity ATTN: SELWS-AJ White Sands, New Mexico 88002	1

DISTRIBUTION LIST (continued)

Addressee	No. Copies
Commanding Officer U. S. Army Electronics R & D Activity ATTN: SELHU-PT Fort Huachuca, Arizona 85613	3
Chief of Research and Development Department of the Army ATTN: CRD/M Washington, D. C. 20315	1
Commanding General U. S. Army Materiel Command ATTN: AMCRD-RV-A Washington, D. C. 20315	2
Air Force Cambridge Research Laboratories ATTN: CRRU L. G. Hanscom Field Bedford, Massachusetts 01731	1
Chief, Meteorology Division T & E Command Dugway Proving Ground Dugway, Utah	1
Commanding General U. S. Army Electronics Command ATTN: AMSEL-RD-ADJ (Responsible File & Record Unit) Fort Monmouth, New Jersey 07703	1
Commanding General U. S. Army Electronics Command ATTN: AMSEL-RD-SMA Fort Monmouth, New Jersey 07703	32
NASA Representative Scientific and Technical Information Facility P. O. Box 5700 Bethesda, Maryland 20014	1

DISTRIBUTION LIST (continued)

Addressee	No. Copies
Commanding General U. S. Army Electronics Command ATTN: AMSEL-EW Fort Monmouth, New Jersey 07703	1
Director of Meteorological Research U. S. Weather Bureau Washington, D. C.	1
Stanford Research Institute ATTN: Mr. Elmer Robinson Menlo Park, California	2